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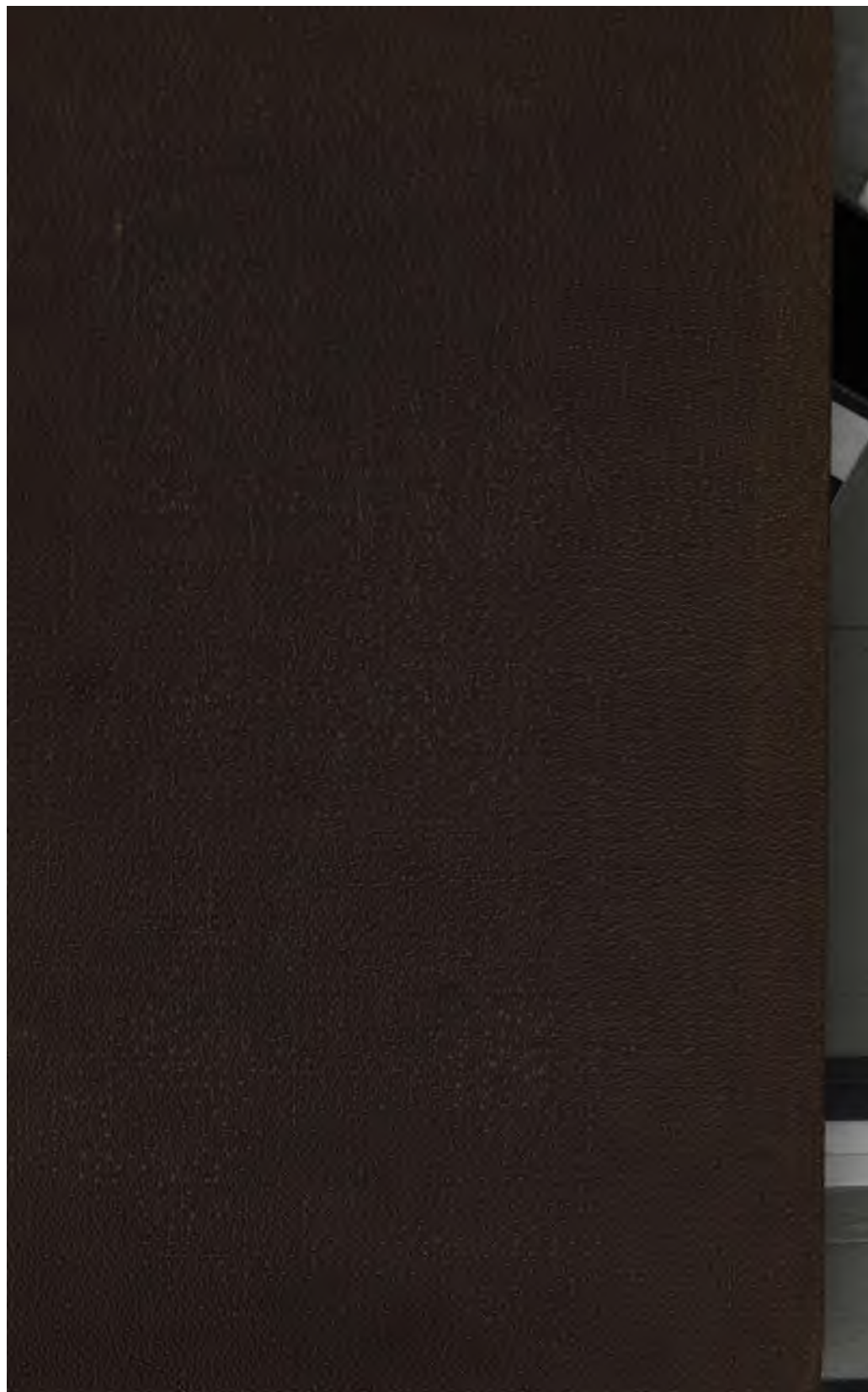
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*James Stewart*

Proceedings  
of the  
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of Glasgow.







CHARTYPE REPRODUCTION OF SEAWEED.

(*Ulva Lactuca*.)

(From Vaguel by Mr. Tard, 1886.)

PROCEEDINGS  
*Royal* OF THE  
PHILOSOPHICAL SOCIETY  
OF GLASGOW.

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VOL. XXI.

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1889-90.

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EDITED BY THE SECRETARY.

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# PROCEEDINGS OF THE PHILOSOPHICAL SOCIETY OF GLASGOW.

EIGHTY-SEVENTH SESSION.

## PRESIDENT'S ADDRESS.

I.—*Sanitation and Social Economics: an Object Lesson.* By  
JAMES B. RUSSELL, B.A., M.D., LL.D., President of the  
Society.

[Read before the Society, 6th November, 1889.]

AT next meeting I shall leave this chair and the elevated position which, by your favour, I have occupied for three years. It is a usage of this Society, the wisdom of which my successor will no doubt fully recognise, to require the retiring President to introduce the Session with an Address. You will see from the subject of this Address, as announced in the billet, that I am not going to lead you into "fresh fields and pastures new." I hope, however, you will think it not altogether unnatural or inexcusable, on my part, to seize this last opportunity of obtaining for an old cause the attention which the eminence of the chair of the Philosophical Society of Glasgow always commands.

In a Report on "The Vital Statistics of the City of Glasgow," published in 1886, in which I described *seriatim* the districts into which the city is divided for statistical purposes, specifying the main physical features of each in relation to the health of its inhabitants, you will find the following with reference to—

### "DISTRICT 14, or 'Bridgegate and Wynds.'

	1871.	1881.
Population, - - - - -	14,294	7,798
Acreage, - - - - -	35	35
Density, - - - - -	408	223
Mean number of rooms per house, - - -	-	1·855
Do. persons per room, - - -	-	2·946

(1880) Percentage of houses of 1 room, 49; 2 rooms, 35;  
5 rooms and upwards, 1.

Percentage of Irish-born, 32.

## DEATH-RATE.

All ages—mean,	1871-2,	42·3;	1880-1-2,	38·3
Under 5 years—mean,	„	166·1;	„	138·7

## BIRTH-RATE, 1880-1-2.

Mean,	37·1
-------	------

## DEATH-RATE.

Under 1 year, per 1,000 born,	206
All ages, from Infectious Diseases,	4·15
Do., Consumption,	5·28
Do., Acute Diseases of Lungs,	11·47
	16·75

Percentage of Total Births, Illegitimate, 22.

Do. Total Deaths, Uncertified, 25.

Do. Do., Insured, 32.

“District 14, or ‘*Bridgewater and Wynds*,’ bears a sufficiently descriptive designation. It lies between Stockwell Street and Saltmarket on the west and east, and Trongate and Clyde on the north and south. The Union Railway occupies the very centre. Between the clearances necessary to its formation and the operations of the Improvement Trust, this District has been, so to speak, disembowelled. Still, in those portions which remain, we find a population the like of which, for social and moral degradation, is not to be found in the City. Their houses, though much has been done for them, are radically bad, and total demolition and reconstruction is the only remedy. To enumerate those plague spots would simply mean to catalogue all the wynds, narrow, noisome streets and closes of this unhappy area, and to bring once more into public notice names which have been the heartbreak of successive generations of Glasgow philanthropists.

“We began this survey of the districts of Glasgow with ‘*Blythwood*,’ which was remarkable as having the lowest proportion of inmates per inhabited room, the largest proportion of large-sized houses, the lowest death-rate, the lowest birth-rate, the lowest mortality under 5 years, the lowest proportion of deaths under 1 year per 1,000 born, and the lowest proportion of Irish-born. We end it with ‘*Bridgewater and Wynds*,’ which has the largest proportion of inmates per inhabited room, the largest proportion, save one, of 1-apartment houses, the highest death-rate over all, the highest death-rate under 5 years, the largest proportion of deaths under 1 year per 1,000 born, and the highest percentage of Irish-born inhabitants.”

It is this district which I propose to take as an Object Lesson on the relation between Sanitation and Social Economics. I quote this passage to satisfy you that, although I shall confine the details of this Object Lesson to the year 1888, I select District 14, not merely because in this single year it was the worst district in Glasgow in all sanitary and social aspects, but because it has *always* occupied this unenviable position. Further, I make the *worst* district in Glasgow my Object Lesson, because there we find in their greatest intensity the physical conditions and the associated

vital and social characteristics which determine the position of every other district in Glasgow in the sanitary scale. The difference in the causes which produce the different results is a difference in degree, not in kind.

Speaking to a Glasgow audience it is unnecessary to spend much time over the location or the physical features and conditions of District 14. I repeat that it is to 1888 that my statements refer. The district embraces an area of 35 acres, in which there are 1,308 houses, inhabited by 7,150 persons. This is 57 per cent. of the total area inhabited by 1·29 per cent. of the total population of the City. The healthiest district of Glasgow, "Kelvinhaugh and Sandyford," or District 17, embraces 10·24 per cent. of the area, and is inhabited by 5·62 per cent. of the population.

*The character of the house accommodation* and the physical conditions generally are sufficiently described in the passage quoted. I shall only add that 51 per cent. of the houses are "ticketed," and are therefore subjected to the system of night inspection for the prevention of overcrowding, described in my address last year. In "High Street and Closes (E.);" (District 6), there are 55 per cent., and in "Cowcaddens" (District 16) 57 per cent. of such houses, while in "Kelvinhaugh and Sandyford" (District 17) there are only 1·4 per cent. District 14 also contains 43 of the total 99 Common Lodging-houses in the City.

There were 232 *deaths* and 218 *births*, so that this district produced 14 fewer lives than it consumed. District 17 had 431 deaths against 811 births, thus contributing a surplus of 380 lives; while the whole city had a surplus of 7,722 lives. Reduced to rates per 1,000 of the population, these figures represent for District 14 a birth-rate of 30·49, a death-rate of 32·45; for District 17 a birth-rate of 26·14, a death-rate of 13·89; for the City a birth-rate of 34·92, a death-rate of 20·91. The infantile death-rate when calculated per 1,000 born is of more value as a gauge of health than the general death-rate, especially seven years after the census, because the data are unquestionable. In District 14 the death-rate of children under 1 year of age was 239 per 1,000 born; in District 17 it was only 88, and in the City 133. This means that in these districts and in the City 24 per cent., 9 per cent., and 13 per cent. of the children born did not survive their first birth-day.

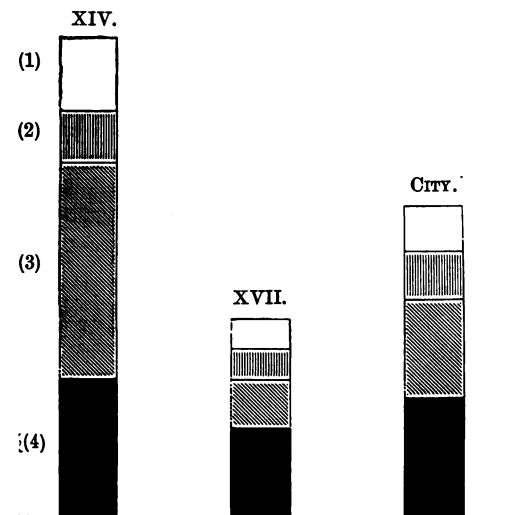
*Illegitimacy* introduces us to the morality of the district. In District 14, 25 per cent. of the children were born out of wedlock,

in District 17 only 3 per cent., and in the City 8 per cent. No district approaches District 14 in illegitimacy: 1·29 per cent. of the population contributes 3·7 per cent. of the illegitimate, and not 1 per cent. of the legitimate births in the City.

In the following table the *comparative mortality* from Zymotic or Infectious Diseases, from Diseases of the Lungs, and from Nervous Diseases and Diseases of Nutrition in Children, in Districts 14, 17, and in the City is exhibited in death-rates per 1,000:—

	XIV.	XVII.	City.
Zymotic Diseases (including Diarrhoea), -	4·76	1·67	2·84
Nervous Diseases and Diseases of Nutrition			
in Children, - - - - -	3·36	1·84	3·00
Acute Diseases of the Lungs and Consumption, -	14·68	3·93	7·00
Miscellaneous Unclassified Diseases, - - -	9·65	6·45	8·07
	<hr/> 32·45	<hr/> 13·89	<hr/> 20·91

These death-rates are shown in a diagram, in which the columns are on the same scale, so that your eyes can estimate not only the



- (1) Zymotic Diseases ; (2) Nervous and other Diseases special to Children ;  
(3) Diseases of the Lungs ; (4) Miscellaneous.

comparative total mortality, but also the comparative fatality of the classes of disease. It is obvious that Infectious Diseases and Diseases of the Lungs are the two scourges of District 14. The death-rate

from Diseases of the Lungs *alone* is greater than the death-rate from all causes in District 17. The comparative loss of life among children is not sufficiently shown from contrasting the death-rates on the basis of the whole population; the proportion of children living below five years being so small in District 14. If we take the deaths from Debility owing to Premature Birth, and represent them in rates per 1,000 born, we not only get a better gauge of the deadly influences to which children are subjected after birth, but we also discover that they extend into intra-uterine life. In District 14, 41 per 1,000 of the children born died because they were born prematurely; in District 17 only 12, and in the City 17·5 per 1,000.

The matter of *Certification* throws some light on the care bestowed upon the sick. If the cause of death is duly certified to the Registrar the person who died must have received some amount of attention. On the other hand, if it is not certified there must have been neglect, and for every such uncared-for death-bed there must have been many uncared-for sick-beds. In District 14, 18·5 per cent. of all the deaths were not certified, in District 17 only 3 per cent., and in the City 5·7 per cent. In some of these cases a medical man was alleged to have seen the patient, but was unable to certify, from lapse of time or from being unable to identify the person. In the majority of cases in District 14 there was no medical attendant. Absolutely no medical man had seen the deceased during their last illness. This was alleged to the Registrar in 15·5 per cent. of the fatal sicknesses in District 14, not in 1 per cent. in District 17, and in 3 per cent. in the City.

The proportion of the deaths in a district in which the deceased was *enrolled in a Friendly Society* gives us a fair indication of the extent to which the virtue of providence or foresight prevails in that district. In District 14, 40 per cent. of those who died were members of Friendly Societies, as compared with 45 per cent. in District 17, and 56 per cent. in the City as a whole. But we must turn to the good working-class districts for a proper comparison. In the District of "Greenhead and London Road" 65 per cent. of the deceased were members of Friendly Societies, in "St. Rollox" District 67 per cent., and in the District of "Springburn" 70 per cent.—the highest in the city. It is quite evident from these figures that the inhabitants of District 14 are not distinguished for providence.

We come now to the *Social Economics* of District 14. What does the existence of this unhealthy area mean to the community of which its inhabitants form a part? *Sickness* in our own families we know means expense. On whom does the cost of treatment fall in their case? We can only get at a partial answer to this question, and in an indirect way, by observing where the fatal cases of sickness were treated. There were 232 deaths. Of these we have seen that 43, or 18·5 per cent., were uncertified, and therefore received no useful, or what can in any sense be considered satisfactory, medical care in their last illness. I find that 69, or 29·7 per cent., died in public institutions, and 120, or 51·8 per cent., died at home, and the cause of their death was duly certified. We may classify the institutions into those supported by public rates and those supported by charity. The distribution of the deaths among the rate-supported institutions was the following:—In the City Poorhouse, 47; in Belvidere Fever Hospital, 10; in the North Prison, 1; in the Central Police Office, 1;—so that the cost of treating those 59 fatal cases of sickness, or 25·4 per cent. of the whole, was defrayed out of public rates. The distribution of the deaths among charitable institutions was as follows:—In the Royal Infirmary, 6; in the Western Infirmary, 3; and in the Maternity Hospital, 1;—so that the cost of treating those 10 cases, or 4·3 per cent. of the whole, was defrayed from the free contributions of the charitable. As I explained to you last year, there are very many deaths which take place, especially in poorhouses, of persons who have been so long resident therein that they cannot be referred to any special address in the city, though they all came from the poor quarters. These deaths remain against the institutions as unallocated. There were 328 such in Glasgow institutions in 1888, and an unknown proportion doubtless originally came from District 14. There are other circumstances which go to prove that 30 per cent. by no means represents either the proportion of the total sickness or the total deaths in this district, which entailed expense upon the public, both as ratepayers and as contributors to such charities as hospitals, dispensaries, nursing associations, and the like. The probability is that very little medical aid is obtained in this district except what the public pay for, or the profession bestow for nothing. The proportion of all the deaths in the City which took place in institutions of all kinds was 15·5 per cent.

The cost of *interment* is a very definite and unavoidable item in the general expenditure which accompanies disease. I find that 86 of the persons who died in District 14 were interred at the expense of the ratepayers, or 37 per cent. of the total. Of these, 49 were interred by the Parochial Board, and 37 by the Sanitary Department, as Local Authority under the Public Health Act. This is exclusive of 10 still-born children, also interred by the Sanitary Department, a suggestive item in the sum of wasted life which is recorded against this unhappy district. No less than 22 per cent. of all the interments, the expense of which was defrayed by the Sanitary Department in 1888, were of children still-born in this and other similar districts in the city. Of those who died in the whole City 9·28 per cent. were interred at the public cost.

Expense attends our entrance upon life as well as our exit from it. Of the *children born* in District 14, 15 were born in the Maternity Hospital and 6 in the City Poorhouse—21 children who began their lives at the cost of charity and the rates, or 10 per cent. of the total births credited to the District; and 21 mothers maintained and provided for. A much larger number of women received the minor benefaction of attendance at their own houses by the doctors and nurses of the Maternity Hospital. The births of 98 children were so attended, or 45 per cent. of the total; so that at least 55 per cent. of the children of District 14 made their début in the tragedy of their lives by the help of charity or the rates, as compared with 25 per cent. in the whole City (3 per cent. in hospital and 22 per cent. attended at home).

*Vaccination* is another item of expenditure necessary to be incurred on behalf of every child born who does not die before the six months allowed by law have elapsed. A large proportion of the children of District 14 do so die, and between the Sanitary Department (86), the Royal Infirmary (21), and the Parochial Vaccinators (?), the vaccination of the remainder is effected—another service defrayed by the ratepayers and the charitable. Approximately, 50 per cent. are thus vaccinated as compared with 25 per cent. in the whole City.

The extent of the *demands made upon the services of the Sanitary Department* by the several districts of Glasgow is clearly shown in the Sanitary Inspector's Annual Reports. If we take various forms of personal work done by officials within the bounds of this small area we shall get some conception of the amount of

public money expended on it merely in the shape of the time of subordinate officers :—

Inspections of Nuisance and Epidemic Inspectors,	-	7,104
Searches after Vaccination Defaulters,	- - -	62
Applications of the Smoke Test to drains,	- - -	17
Inspections of Common Lodging-houses,	- - -	3,002
Do. Houses Let in Lodgings,	- - -	108
Night Inspections of Ticketed Houses,	- - -	2,620
House Visitations by Female Inspectors,	- - -	3,616
		<hr/>
		16,529

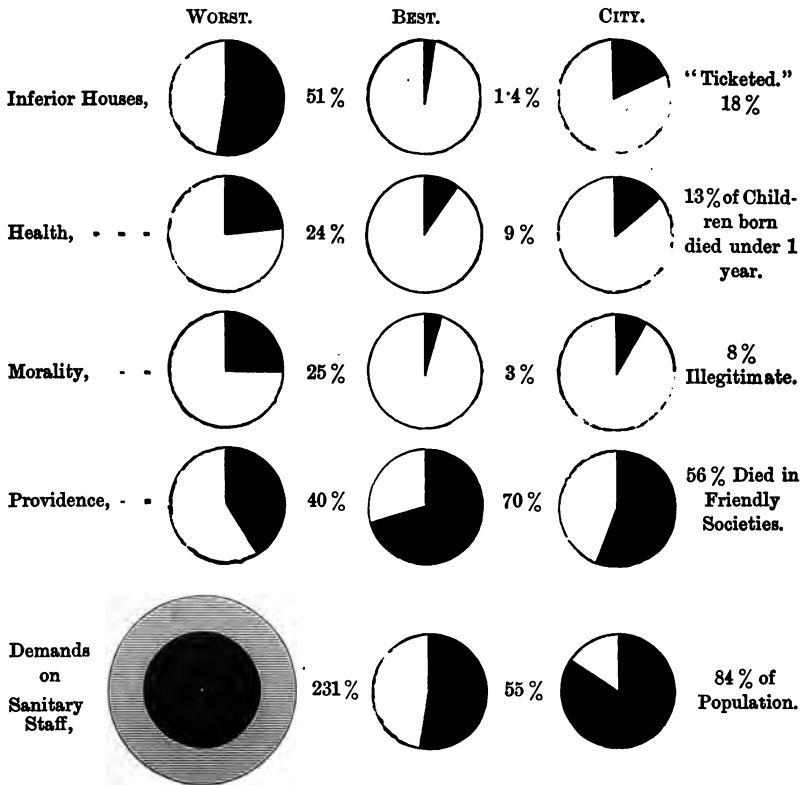
—being a grand total of 16,529 individual expenditures of official time within the district, or 231 per hundred of the population. In District 17 the same services amounted only to 53 per hundred of the population, and in the whole City to 84. Behind all this personal service within the district follows a proportionate amount of office work, of expenditure for the removal of nuisances, of work in Police and other Courts, of outlay in treating infectious disease, in cleansing and disinfecting houses and clothing, and otherwise in carrying out miscellaneous sanitary operations. The nuisances discovered amounted to 38 per hundred inhabited houses in District 14, as contrasted with 15 in District 17, and 16 in the City as a whole.

I cannot present you with a similar precise comparative statement of the *demands made upon the official time of the other Public Departments*, but I fancy the review of the long procession of statistical details which I have made to pass before you has convinced you that these demands must be in somewhat the same excessive proportion as compared with the other districts of the city as in the case of the Sanitary Department. There is the Police Department. Notwithstanding the undoubted improvement of the past 20 years, District 14 is still the Alsatia of Glasgow. It is still the headquarters of those who live in open defiance of the law. I have the authority of the Captain of Police for saying that it furnishes the greater part of the work of the Central Police Court. It would be safer to fall asleep at the foot of a tree in Central Africa than at the foot of a lamp-post in the Bridgegate. One has only to walk through it and observe how in the day time, when in a normal working-class district only children are seen in the streets, there every close has its knot of idlers; and to enter the houses where only mothers are to be seen elsewhere and find men and women sleeping by day in preparation for the dismal

work of the night, to understand how freely the police rate is expended in or because of District 14. The Cleansing Department is largely occupied in sweeping-up and removing filth which is thrown over the windows and deposited about the courts.

GLASGOW, 1888.

VITAL STATISTICS AND SANITARY DEMANDS OF DISTRICTS  
XIV. (*Worst*), XVII. (*Best*), AND CITY.



*N.B.—Demands on Police, Cleansing, Parochial, and School Board services in like proportion.*

There are men employed doing nothing else but going round these courts and closes every few hours throughout the day with brush and hose and water-pail, and yet they are never clean. It is but fair to the inhabitants to add that these bad habits are encouraged,

if not caused, by the abominable privy system. There are only 105 W.C.'s in the whole district. Just as the officers of the Sanitary Department have to hunt for vaccination defaulters there, so have the School Board officers to concuss parents and follow up children. The Parochial officers also are never out of this district. It sends large contingents to Industrial Schools, Reformatories, Day-feeding Schools, Orphan Homes, and the like. It surrounds the Free Breakfast Table with its hungry crowds. It scours the West-End with its beggars, and is, in short, in words which I used many years ago, "a sort of running sore upon the body of the community, diverting its substance from healthy uses, and draining the life-blood of the public."

So far, I have been giving you the various items on the debit side of the social account of District 14. Let us turn now to the credit side, in so far as it can be shown from *the payment of rates*. For the purposes of my argument it is necessary that I should remind you of the incidence of municipal taxation in Glasgow, which is, as regards the rates which are chiefly affected by the characteristics of District 14, I believe, peculiar to Glasgow; and the effect of this peculiarity of incidence is to make my argument more weighty as applied to Glasgow than to any other city in the kingdom.

(1) Occupiers at rents of £4 and under are assessed for no municipal rates whatever. The owner is liable for Police, Statute Labour, and Sanitary Assessments (Local Act), under a deduction of 25 per cent. He is further liable for the Roads and Bridges and Public Health Assessments on the same class of property without deduction. No assessment is made on such rentals for City Improvement, Parks and Galleries, or any other municipal purpose.

(2) All rents are assessed at a uniform rate for Statute Labour.

(3) All rents below £10 are assessed for the Police Rate proper (for Police, Cleansing, Lighting, Fire Brigade, Baths and Wash-houses, &c.), and the Sanitary Rate (Local Act), at half rates; that is to say, at £10 and upwards the rate per £1 is twice the rate below £10 (including £4 and under), and above £4 the whole assessment is raised from occupiers.

(4) There are other rates, such as for Municipal Buildings, Registration of Births, &c., Lunacy and Prison Payment, which are assessed half from owners and half from occupiers, the owners' half being charged on rentals at £4 and upwards, and the

occupiers' half on rentals above £4; while the Juvenile Delinquency rate is also levied on rentals above £4, but wholly from occupiers.

(5) A special rate for the cleansing of private streets and courts is levied upon their proprietors.

It is evident from this peculiar local arrangement of the incidence of taxation that the occupiers of subjects rented at £10 and upwards are, in respect of the cost of Police, Cleansing, and Sanitation generally in Glasgow, burdened by law with a disproportionate share of the outlay created by the lower-rented occupiers, who are notoriously the class who make the heaviest demands on the rates for these purposes. Therefore, supposing everybody paid his or her legal share of this taxation, it would still be true that the householders of such a district as 14 do not contribute, on the basis of rental, an equal share of the cost of those public services which they require so much in excess of the householders of other districts. The case is much the same as would exist if the owners of property in which fire-risks were excessive were required to pay a lower premium for fire insurance than the owners of property in which fire-risks were very slight. Still, if such was the law, and the low premiums and low rates were duly paid, no moral blame would attach to those who held property or occupied houses under such fortunate conditions. But the situation is very different in the case of the police rates. Those who are rated on rentals under £10 and above £4 are conspicuously the worst payers. I find appended to last Annual Financial Statement of the Magistrates and Council of Glasgow (Police) a table showing for a series of years the "number of persons assessed, paid and unpaid." In 1888-89 there were 55,773 occupiers assessed at the full rate, of whom only 963, or 1·7 per cent., did not pay; while there were 75,520 occupiers assessed at the half-rate, of whom 15,453, or 20·46 per cent., did not pay. Under occupiers are included not merely householders, but occupiers of all subjects at the respective rentals; but the defaulters are almost invariably householders, and therefore the percentages give a comparison rather favourable than otherwise to the occupants of houses rented at £10 and above £4.

It is evident, therefore, that in Glasgow, beyond all other cities, the high-rated householder and large ratepayer of all denominations have good reasons for looking narrowly into the economics of the low-rated householder. Part of his rateable burden is put upon

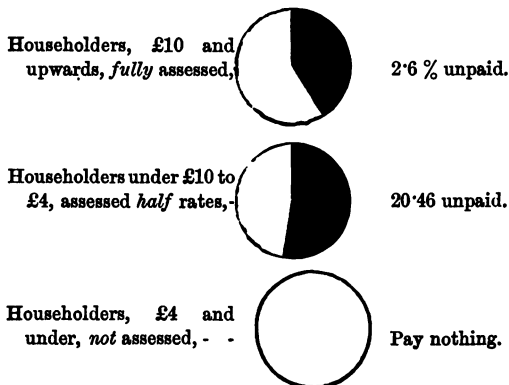
the broad back of the larger tenant-ratepayer by law, and he seems to do what he can to impose the rest by default. If we take the number of householders alone at £10 and upwards, and reckon every defaulter who occupies a subject at that rental to have been a householder, we find 963 defaulters to 36,212 householders, or

GLASGOW, 1888.

INCIDENCE OF TAXATION AND PAYMENT OF RATES.

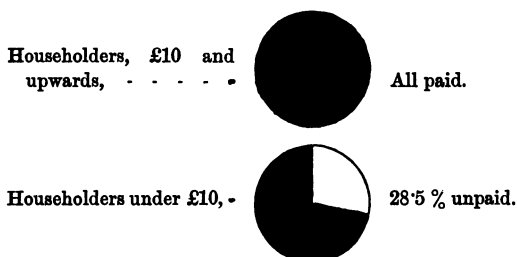
I. — *POLICE RATES.*

(Graded Assessment.)



II.—*POOR AND SCHOOL RATES.*

(Uniform Assessment.)



2.6 per cent., as compared with 20.46 per cent., of the lower-rented and half-rated householders.

Poor rates and school rates are levied on 80 per cent. of all rentals, half on owner and half on occupier. The whole amount of the owners' rates is recovered, but again, in the case of the

occupiers, a large proportion of the legitimate burden of the lower-rented householder is by default imposed upon the other ratepayers. From the fact that political disfranchisement ensues upon non-payment of poor rates by householders under £10 rental, the Collectors of the several parishes are required to report the defaulters annually to the City Assessor. In 1888-89, he informs me, there were 24,627 householders under £10 who were so reported. From the same source I learn that there were 86,491 houses under £10 (*including unoccupied*), so that at least 28·5 per cent. of the householders under £10 paid no poor rates or school rates.

From the political results of non-payment of poor rates, from the fact that their collection is probably more stringent than that of any other rate, and from the uniformity of their incidence on every rental, I believe we may take the number of householders who pay no poor or school rates as a fair census of those who contribute nothing to the rates of Glasgow. A confirmation of this is obtained by the curious agreement of the figures reached by three distinct paths :—

1. Householders under £10 reported under the Registration Act as having failed to pay Poor Rates, - -	24,627
2. Occupiers under £10 and above £4 who failed to pay Police Rates, - - - - -	15,453
Occupiers £4 and under who pay no Police Rates, - - - - -	8,559
	<hr/>
	24,012
3. No. of Ticketed Houses in Glasgow, - - - - -	23,288
	<hr/>

These figures can leave no doubt on any one's mind that we are practically dealing with the same persons all through, and I think we may safely state the number of householders in Glasgow who put nothing into the public purse, while they take freely out of it, at 24,000; which represents, at the moderate allowance of 3·5 persons per household, 84,000 souls. I find from returns furnished by the Collector of the City Parish that 20 per cent. of those who did not pay in that parish were relieved on account of poverty. A return prepared by the Treasurer of Police in 1884 showed precisely the same percentage of relief extended to poor persons—another coincidence which shows that we have the same persons in both categories. Therefore we may divide our 24,000 into 4,800 relieved by the authorities, and 19,200 who relieved themselves; or, to be generous, let us say 5,000 honest poor and 19,000 fraudulent householders!

Now, where are we to look for these householders? To get at the facts regarding all the householders in District 14 was a task which I could not ask my willing friends, Mr. Henry, the City Assessor, Mr. Reid, the Collector of Police Rates for the Central District, and Mr. Hall, the Collector for the City Parish, to undertake, though I believe they would not have refused me, so interested were they in my inquiry. What I did was this: I obtained from Mr. Henry a copy of the Valuation Roll of two of the worst localities in the district. I gave it to the two Collectors and asked them to tell me the result of their collection for 1888-89 as regarded the householders. I submit their statement:—

**ST. MARGARET'S PLACE BLOCK**—the area bounded by the Bridgegate and Jail Square, Saltmarket and Market Street. A recent special census showed that 665 persons resided in this block, and in the seven years, 1882-88, the mean general death-rate was 50 per 1,000, and the death-rate under one year, per 1,000 born, 234. There are four public-houses in this block, the rental of which is £295, and seven shops for the sale of food-stuffs, the rental of which is £136 15s.

1. *Municipal Rates so far as payable by householders.*—Number of householders rated direct, 116. The total amount of assessment due by them was £42 4s. 4d. Of these, 50 paid, the amount recovered being £19 12s. 3d.; 66 did not pay, the amount lost being £22 12s. 1d. That is to say, 57 per cent. paid nothing, and £53 10s. 10d. per cent. of the municipal assessments due by householders was lost.

2. *Poor Rates and School Rates.*—There are 147 householders (including three houses and shops), of whom 82, or 56 per cent., paid nothing. The amount of poor rates due was £18 9s. 6d., the amount paid was £10 17s. 1d. The amount of school rate was £12 4s. 2d., the amount paid was £7 3s. 5½d.

**118½ BRIDGEGATE**—two tenements which, in January, 1888, were ascertained to have 116 inhabitants. In the seven years, 1882-88, the mean general death-rate was 56 per 1,000, and the death-rate under 1 year 379 per 1,000 born. This block contains one public-house, the rental of which contributes 28 per cent. of the total rental of occupied premises, according to the Valuation Roll.

1. *Municipal Rates payable by householders.* Number of householders rated direct, 20; amount of assessment due, £8 0s. 9d., none of which was paid.

2. *Poor Rates and School Rates.*—There are 23 householders (including one house and shop), of whom 15, or 65 per cent., paid nothing. The amount of poor rates due was £2 6s. 2½d.; the amount paid was 18s. 3½d. The amount of school rates due was £1 10s. 6½d.; the amount paid was 10s. 10d.

It is interesting to note how the Gas and Water Trusts cover the risks of doing business with this class of the population. The Gas Trust is protected by having the power to insist upon a deposit as a security before gas is supplied. The consequence is that a considerable proportion of the low-rented tenants, especially those rented at £4 and under, use no gas at all, but are contented with paraffin lamps. The landlord is responsible for all water rates on rentals under £10. The history of the deduction allowed by successive Water Acts tells its own tale. In 1855 the landlord was allowed 10 per cent. all round. On representations of their losses in 1865, this deduction was raised and graded; on rentals under £10 to £7 the landlord was allowed 15 per cent. off, below £7, 20 per cent. In 1885 the reduction below £7 was further raised to 25 per cent. So that the people who pay no police or poor rates endeavour, so far as they can, to obtain water, one of the primary necessities of life, at the cost of the community.

The last bit of information I shall give you regarding District 14 is a return with which the City Assessor has favoured me of the rental of licensed premises as compared with the rental of premises where food alone is sold, within this district:—

#### 1. LICENSED PREMISES.

No.	Kind of Premises.	Rental.
43	Public-Houses, - - -	£5,167 2 0

#### 2. PREMISES WHERE FOOD SUPPLY IS OBTAINED.

No.	Kind of Premises.	Rental.
43	Unlicensed Grocers, - - -	£1,363 12 0
1	Greengrocer, - - -	16 0 0
4	Bakers, - - -	95 0 0
4	Dairies, - - -	86 0 0
11	Confectioners, - - -	222 0 0
4	Miscellaneous, - - -	44 0 0
20	Restaurants, - - -	1,436 10 0
6	Butchers, - - -	259 10 0
7	Fishmongers, - - -	257 0 0
3	Lodging-Houses (selling food), -	165 0 0
1	Fish Market, - - -	1,000 0 0
Total, - - -		£4,944 12 0

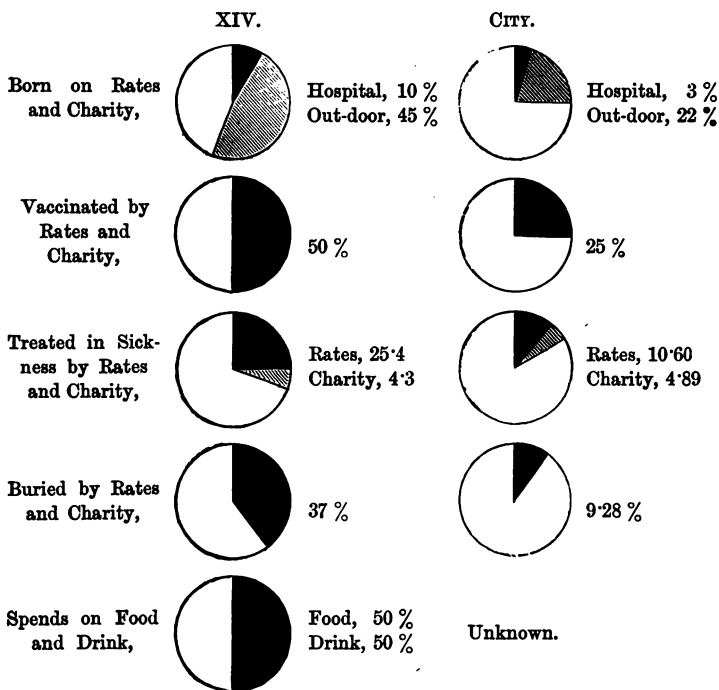
The rental of public-houses in District 14 is £5,167, and of premises where food of various kinds is sold without "drink," £4,944. It may be said that the whole of the south side of Trongate is included in this district, and that in a great public thoroughfare in the centre of the city the public-houses supply the wants of passengers rather than of the residents. This is true, but it will be observed that £1,000 is thrown in on the other side, the valuation of the public Fish Market, which is the centre of the wholesale fish trade, not of the city merely, but of its suburbs. Besides, the temperance restaurants, which are so numerous, and even the unlicensed grocers, share in the business of passengers as well as public-houses. On the whole, therefore, the return must be held to shed useful light on the comparative place of necessary food and the luxury of drink in the life of the locality. District 14 seems to spend as much on the one as on the other. I think, as honest business men, apart from all views as to total abstinence or the association of crime, immorality, and disease with excess in the use of alcohol, you will agree with me in thinking that people who do not pay their rates, who throw themselves on the legal and charitable resources of the public in their sickness, their birth, death, and burial, simply take from the pockets of the public every sixpence which they spend upon drink.

Now, gentlemen, all the facts of the case of District 14 are before you. I told you at the outset that I selected this district for an object lesson, because there we had in their greatest intensity the same kind of insanitary conditions associated with disease, death, crime, pauperism, neglect of social obligations, as you find in all the unhealthy areas and tenements of the city. Wherever you find those insanitary conditions you may foretell that a similar investigation will disclose in proportioned degree the same associated social characteristics. There you find a people unhealthy, reckless, spendthrift of their own and the public money, contributing little or nothing to the public purse, tinged more or less with immorality and crime. Guided simply by the abnormal death-rates, I could take you to the districts and tenements in which the main body of those 24,000 householders live—in High street and its closes, in Calton, in Cowcaddens, in Gorbals, and in small colonies chiefly in "back lands" dotted here and there over the city. Supposing you had them all transported in their more or less unwholesome tenements to some distant plain, you would then

have a city larger than Greenock, and what a city!—certainly not the “new Jerusalem which cometh down out of heaven.” Supposing you were told that you must pay all the rates of this parasitic city, pave and sewer its streets, light it, cleanse it, watch it, build and maintain prisons for its inhabitants, pay for attendance at their birth, build hospitals for them, treat their sick,

GLASGOW, 1888.

COMPARATIVE DEMANDS ON RATES AND CHARITY OF  
DISTRICT XIV. AND CITY.



bury their dead, educate their children—would you not at sight of the multitude, and in view of the solid mass of obligations to be imposed upon you, begin seriously to think what you could do to get rid of them? Would not the vision of that dismal shadow of your city haunt your dreams? Should we not have fierce orators storming through the municipal wards protesting against Communism and Socialism? Yet these people are living all up and

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down the city, and you are now bearing the full burden of these obligations. You cannot get rid of it while such places and such people exist. No thought among the many which this inquiry has called up in my mind has so deeply been impressed upon me as the various, often circuitous, but always certain, paths by which, as society is now constituted, these people requisition your material resources. They cling to you as the garment steeped in the poisoned blood of Nessus clung to and consumed the living body of Hercules. If you will not pay in the shape of improvement rates for the removal and reconstruction of their unwholesome dwellings, you must not only pay *their* rates but expend *your* rates upon them. If you object to pay for the prevention of their disease, you must pay for the treatment of their sick, and you must at least bury their dead. After their poverty has exhausted the provisions of the law, it seizes hold of the skirts of your benevolence and will not let them go until it receives a dole.

My object throughout this address has been simply to raise in your minds the question—"Does it pay to have such houses and such people in the City?" This seems a sordid question, but after all it is the case that the claims of social morality and the dictates of practical Christianity work themselves out in the civic and national ledger. In view of the facts before you there can be but one answer to the question. The city which imagines it can save money by letting District 14 alone reminds me of a man who has a limb which throbs and aches with some chronic disease, while his body wastes with hectic fever and sleepless nights, yet he refuses to part with the limb.

Observe how nature deals with such districts. As I pointed out to you, District 14 consumes more life than it produces. It is the largest continuous area in the city of which it can be said that the deaths every year outnumber the births; but this is a characteristic of those blocks and isolated tenements which are scattered about the city. All you have to do is to draw a cordon round them, so that no recruits shall join the inhabitants, and year by year their inhabitants would dwindle away and ultimately become extinct. What can we do to prevent the ranks of this class from being recruited? I believe one of the most important steps we can take as a community—a step without which no others will avail—is to get rid of the unwholesome tenements to which they are attracted as iron is to a magnet. I have heard it *said* we must have such places for such people, but I deny it.

The man who says so, who is generally the owner of such property, would shrink from becoming known as the landlord of thieves and loose persons. I noticed this wholesome feeling in a recent discussion of the Town Council with reference to the property held by the Improvement Trust in this very district. To speak of building houses to be let to the inhabitants of insanitary dwellings, is to speak of something which never has been done and never will be done. What is done is to select respectable, steady tenants, and put a caretaker in every block, and if the class of people referred to choose to become such they can get suitable houses at any time. They never will while their present dwellings are allowed to exist as they are. In this district there are shops where the beggars sell the bread and scraps of meat which you give them, that they may procure drink with the proceeds. The inhabitants buy those scraps rather than wholesome food, that *they* may have more money to spend on drink, and they resort to these houses for no other reason. In the main, it is not want of money, so much as want of self-restraint in the use of the money they have, which keeps them there. Nothing shows this so well as the system of sub-letting which prevails in District 14. I have received from the City Assessor a list of houses which are held by 16 persons in this district. They are 116 in number. The total rental paid to the proprietors is £537 8s. The average rent of each house is therefore £4 13s.—some are rented as low as £2 10s. All are sub-let in rooms, or even parts of a room—generally to husbands and wives, frequently with children—at 6d. to 8d. per night. True, they get furniture, bedding, and cooking utensils; but as a rule these are of the most meagre, miserable description. This means £7 16s. to £10 8s. per annum for a fraction of a house. One man in this district leases 36 wretched houses, for which he pays £122 2s., an average of £3 8s. a year. The sub-tenants pay 6d. to 8d. per night; Sunday does not count, but on each other day this sum must be paid in advance. Nor are these casual tenants; they live there and pay these extravagant rents for months or even years. If you point out to the sub-tenants that they are paying sums which would secure the best one- and two-room houses in the city, simply because they never have a month's rent in hand, you generally discover—what other signs sufficiently show—that their position is the same as that of the fast young man who borrows £50 on a £100 bill, and pays 10 per cent. on the full amount of his bill.

These opinions of mine may seem harsh, but they are formed from a study of the facts from the inside ; not from a surface view acting on an impulsive, vague philanthropy. I am glad, in conclusion, to refer you to two opinions based on the same method of close internal study which are in entire agreement with those I have now expressed to you. One is that of Miss Octavia Hill, which you will find in a paper published in the *Nineteenth Century* (September, 1889), entitled "A Few Words to Fresh Workers." She points out how frequently one finds unhealthy courts crowded in close proximity to healthy blocks where there are numerous vacant houses. She asks and answers the question—"Why is this? The sympathetic visitor is too apt to jump to the conclusion that in the healthy blocks the rents are too high for the tenants in the court. Will he inquire what the rents are in each? If he does, ten to one he will find the rent, room by room, far cheaper in the healthy blocks than in the court. He will find that in many—I had nearly said most—instances the reasons why the good rooms stand empty and the bad ones are full, are these :—(1) In the court, overcrowding and sub-letting are tolerated. (2) The rent, nominally high, is either only half paid or is reduced by sub-letting and overcrowding. (3) The drunkenness and profane language, violence and destructiveness, tolerated in these courts would not be allowed by any respectable landlord or neighbours. (4) Bad characters are allowed to frequent the courts." For these reasons she is opposed to the application of rates to the provision by public authorities of houses which will compete with an already sufficient number provided by private enterprise, under proper building and sanitary regulations.

My other reference is to a series of recommendations adopted by the Health Committee of Edinburgh, after full consideration of a report by the burgh engineer upon the insanitary condition of St. Giles' Ward in that city. These recommendations are six in number, but I omit the 4th and 6th, as they are only of local importance :—

"1. That, with the approval of the Magistrates and Council, it should proceed in the work of closing insanitary and uninhabitable houses, as, from inquiries made, the Committee is satisfied that the parties removed from such houses readily find accommodation elsewhere, and it is believed that in most cases they are quite able to provide themselves with better dwellings.

"2. After consideration of statistics relating to St. Giles' Ward,

the Committee is of opinion that the number of licensed houses in the district is largely in excess of its requirements, and that by the temptation thus offered to those with little self-control, the work of the Committee is opposed and many evils caused, some of which are expressed in inferior houses and a high death-rate.

"The Committee therefore recommends that the Town Council should put these opinions before the Magistrates, with a request that they should, as opportunities present themselves, reduce the number of licensed premises in this ward.

"3. That whenever uninhabitable houses, or other property situated in this densely-populated district, can be acquired at a reasonable figure, such property should be secured by the Town for the purpose of being reserved as open spaces, and for the improvement of the sanitary condition of the locality.

"5. The subject of water-closet accommodation is one which engages the attention of the Magistrates and Council regularly, and the Committee recommends that, as heretofore, the owners of properties should be required to provide sufficient accommodation wherever necessary."

These recommendations were unanimously adopted by the Town Council of Edinburgh only last month, and I think, on the facts which I have submitted to you, they are equally applicable to District 14 and other portions of the City of Glasgow.

II.—*Electrification of Air by Combustion.* By MAGNUS MACLEAN, M.A., F.R.S.E., and MAKITA GOTO (Japan), Physical Laboratory, University of Glasgow.

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[Read before the Society, 20th November, 1889.]

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(PLATE I.)

ARRANGEMENTS were made about the middle of last April for a series of observations on natural atmospheric electricity within the Natural Philosophy Class-room, Bute Hall, tower, and various other rooms in the Glasgow University Buildings, in continuation of experiments performed by Sir William Thomson in the rooms of the University, High Street, Glasgow, some twenty-seven years ago. The results then obtained are published in Sir W. Thomson's reprint of Papers on Electrostatics and Magnetism. (See Sec. 296.)

The object of the experiments commenced this year was to find (1) the state of the air inside a room as regards electrification; (2) the relation between the electrification of the air within a building and the atmospheric potential in its neighbourhood outside; and (3) the causes which produce or change the electrification of any given mass of air.

Our method of observation was as follows:—An insulated water-dropper (see Sec. 262, Papers on Electrostatics and Magnetism, by Sir W. Thomson) was connected to one of the terminals of a Thomson quadrant electrometer, the other terminal being connected to the case of the instrument and to a gas pipe or water pipe for "earth." A paraffin lamp and scale were used, and the deflections were read in the usual manner by observing the reflected spot of light.

The needle of the electrometer was previously charged to a certain potential, which was kept constant from day to day by means of the replenisher. The sensibility of the quadrant was always about 30 scale divisions per 1 volt difference of potential between the two terminals of the electrometer, so that we could easily read differences of potential of  $\frac{1}{30}$  volt. This sensibility also allowed us, by putting our zero (obtained by joining the two terminals of the electrometer to each other and to earth) at the middle of the scale, to measure up to 17 volts either in the positive or negative direction; so that, thus using the instrument hetero-

statically, and with the sensibility mentioned, variations of potential from  $\frac{1}{30}$  volt to 33 volts could be observed.

Two such arrangements were used, one in one room, and the other in another room, or both in one and the same room with one water-dropper in the centre of the room, and the other discharging out through a window as described in the article already referred to.

Readings were taken every half-minute, generally for a period of 30 or 40 minutes, and by comparing watches before-hand it was possible to obtain simultaneous readings of both instruments, however far apart the different rooms were.

Up to the 3rd of July 106 such observations were made. We also had 34 observations of the potential of the air outside, obtained in front of the University buildings by the portable electrometer and a burning match, in the manner described in Thomson's reprint of Papers on Electrostatics. Except on two days the potential of the outside was positive. On one day of drizzling rain accompanied by a cold east wind it was negative during the entire time of observation. On another day there were thunder and lightning, and the electrification changed from positive to negative, or *vice versa*, sometimes with very great suddenness.

The following table shows the number of observations in each room, the number of those that showed positive electrification, the number that showed negative electrification, and the number that showed change from positive to negative or from negative to positive during an observation :—

Room.	Number of observations.	Number showing		Number in which electrification altered from negative to positive or <i>vice versa</i> .
		Negative Electrification	Positive Electrification	
Physical Apparatus Room,	35	20	2	13
Class-Room, ... ..	13	9	4	0
Bute Hall, ... ..	13	8	4	1
Museum Room, ... ..	8	8	0	0
First Room of Tower, ...	8	1	1	6
Bell " " ... ..	9	2	6	1
Top " " ... ..	16	6	5	5
Cellar, ... ..	4	4	0	0
	106	58	22	26
In Front of University, observed by Portable Electrometer, ...	34	1	32	1

The Apparatus Room is on the first storey of the University buildings, immediately above the Physical Laboratory and Dynamo Room. It is 40 feet long and 34 feet broad, with two parallel cases of instruments running along its length. During all our observations experiments were actively carried on in the laboratory, such as testing Sir W. Thomson's standard balances, testing dynamo, &c., &c. ; and the electric leads\* from the dynamo to Sir W. Thomson's house pass up at the end of the room. The Bute Hall is also on the first storey. It is 116 feet long and 70 feet broad and 70 feet high. The Physical Apparatus Museum Room is on the second storey, and is considerably further away from laboratory disturbances than any of the three rooms already mentioned. It is  $31\frac{1}{2}$  feet long and 24 feet broad.

That which is called the first room in the tower is a storey higher than the Museum Room. It is 25 feet by 25 feet, and 25 feet high.

The Bell Room is two storeys higher than this room. It is 25 feet by 25 feet, and 45 feet high. It contains the bells of the University. There are eight pairs of windows, two on each side of the tower. The upper half of these windows has the glass taken away so that the wind is blowing in freely. Sometimes, indeed, there was a difficulty in keeping the paraffin lamp lighted in this room on account of gusts of wind. The top room of the tower is above this one, and is 25 feet by 25 feet, and 20 feet high. Its windows are also broken in some places. The height of this room above the level of the front of the University buildings is about 170 feet.

What is called the cellar is a room below the level of the quadrangle, and near the rooms where the boilers and engine for heating the University buildings are placed.

For all the observations curves were drawn, which were compared most carefully, but no definite relation could be discovered

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\* The effect of the electric-light wiring was tried on 24th April in the Natural Philosophy Class-room, which is the next room to the Apparatus Room. The electrometer and water-dropper were set up on the class-room table, and when the reading indicated about four volts negative, the negative lead of Sir W. Thomson's house electric-light circuit, which passes through the class-room, was joined to earth. This changed the deflection of the electrometer by one volt in the positive direction. When the positive lead was "earthed," the deflection was changed by six volts in the negative direction. Putting on sixteen electric lamps, eight on either side of the class-room, changed the deflection by two-thirds volt in the negative direction,

APPARATUS EMPLOYED.

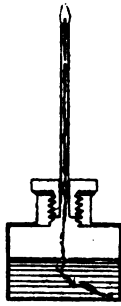


Fig. 8.

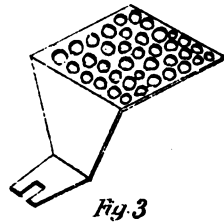


Fig. 3.

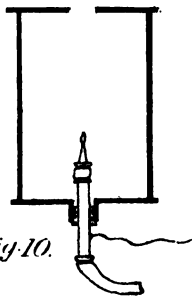


Fig. 10.

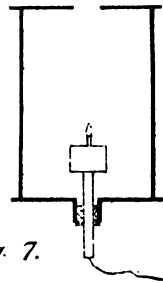


Fig. 7.

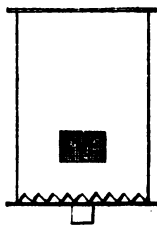


Fig. 5.

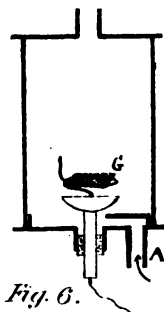


Fig. 6.



between the electrification of different rooms in the University. or between the electrification of any of the rooms and the external potential. It would be too tedious, and, perhaps, serve no good purpose, to give particulars about all these observations. As specimens, the four pairs of curves\* are given in Fig. 1, Plate I.

The first pair gives a comparison between the results obtained in the Apparatus Room and those obtained in the first room of the tower. The observation was made on the afternoon of the 22nd of May. The day was dry and warm, and the electric potential in front of the University, as indicated by the portable electrometer, was very high positive.

In the second pair is given a comparison between the Apparatus Room and the cellar. The observation was made during the forenoon of the 31st of May.

The third pair gives a comparison between the inside and the outside of the top room of the tower. For determining the outside potential, the nozzle of one of the water-droppers was put out through one of the windows, and the deflections of the electrometer (which was inside) were observed in the usual manner. The observation was made in the forenoon of the 27th of June.

A comparison between the inside and the outside of the Physical Apparatus Museum Room is shown by the fourth pair. It was obtained on the afternoon of the 2nd of July, when it was noticed that the potential of a room, if otherwise free from electric disturbances, tended generally to increase negatively during the first ten or twenty minutes of observation, and this increase was specially noticed in the Physical Apparatus Museum Room. Our experiments were now directed to the ascertaining of the cause of this change, and the finding out of the causes which produced the electrification of the air of the room in which we experimented.

On the 15th of July, Sir William Thomson communicated to the Royal Society of Edinburgh a paper on "Electrification of Air by Flame," in which the effect of an ordinary paraffin lamp—the only flame we had tried up to that date—is described. From that paper we quote the following:—

"In one ordinarily unused room (the Physical Apparatus

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\* In all the curves the abscissæ represent time in minutes, and the ordinates differences of potential in volts. The scale of the ordinates of the curves for the outside is a tenth of that of the other curves—thus 1 represents 10 volts.

Museum),  $31\frac{1}{2}$  feet long by 24 feet broad, and about 20 feet high, practically quite free from any sensible disturbance by electric-light wires, or by electrical operations being performed in the Laboratory, a remarkable result has been observed within the past fortnight. The electric potential of a water-dropper, having its nozzle at the centre of the room, and about seven feet above the floor, was always found about two volts negative at the commencement of the observations, and always increased to about nine volts in the course of the first twenty minutes of a series of observations lasting generally forty minutes. During the last twenty minutes of the series the potential remained somewhat nearly constant at nine volts. Within the room, two quadrant electrometers, each with an ordinary paraffin lamp and scale, were used—one of them for the outside water-dropper, and the other for the water-dropper within the room.

“Towards ascertaining the cause of this change, an observation was made on the 4th July between 10 and 11 A.M. The lamps were both extinguished, and one of them was lighted by a lucifer match every five minutes, for the purpose of reading the electrometer deflection. It was found that in these circumstances there was not the increase of negative potential which had been found in every previous series of observations in the same place, and with all other circumstances the same, except the burning of the lamp. This single observation seemed to prove conclusively that the burning of the lamp gave a negative charge to the air of the room.”

Arrangements were made after this to place the electrometer and its lamp outside the room, and observation made, with no lamp burning inside, or with one or more lamps burning inside. A largenumberof observationshas fully confirmed the result just stated.

Curve No. I. (Fig. 2) is one of many which will serve to show the effect. The observation was made on the afternoon of the 9th of August in the English Literature Class-room, which is on the ground floor of the University. It is 37 feet by 34 feet and 24 feet high. The curve shows that as soon as the windows were opened the negative electrification began to be diminished, a change which was due, no doubt, to the coming in of the external air.

After this date the paraffin lamp was dispensed with, and a telescope was used to observe the deflections of the electrometer needle by the mirror attached to it. In all subsequent experiments water-dropper, electrometer, and telescope were in the same room, as it was found that the effect of one or two persons in the room

was practically nothing. The observations were made in the following way:—The water-dropper having been filled and allowed to run, the variations of the electrometer needle were observed by the telescope for five or ten minutes. Then the burning substances were placed generally on the floor below the nozzle of the water-dropper, which is 7 feet above the floor, but sometimes in other parts of the room, and the observation continued for ten, twenty, or thirty minutes.

We here give a list of various kinds of flames and fires which were tried:—Charcoal, paraffin lamp, coal-gas, alcohol; smokeless coal, lucifer match, wood, ordinary paper (either with a flame or glowing), sulphur, magnesium, phosphorus exposed to air, and electrometer match (blotting paper soaked with nitrate of lead). The first four in the list are arranged in the order of magnitude of their effect. With the exception of charcoal, alcohol, coal, and glowing wood or paper, the effect of the other substances was distinctly to electrify the air of a room negatively. Alcohol and the smokeless coal have a doubtful effect. Burning charcoal electrifies the air of a room positively, and it does so quickly and largely. Curve No. 2 (Fig. 2) will serve to show the effect. It was obtained in the Physical Apparatus Museum Room on the 23rd of August, and it illustrates the effect not only of burning charcoal but also of a burning paraffin lamp.

A number of observations of this nature satisfied us as to the effect of each burning substance on an enclosed mass of air. We reasoned that if a burning substance electrifies the air negatively, the substance itself must become positively electrified, and we devised the arrangement described below for testing this conclusion.

A strip of sheet copper, about 3 centimetres wide and 7 centimetres long, is bent into the form of the letter Z (Fig. 3). The lower end of the Z is joined to one of the terminals of the electrometer (Fig. 4), and the burning substance or small copper lamp in which the substance burns is placed on the upper end, which is perforated. The cylinder A, 25 cms. long and 12 cms. in diameter, also made of sheet copper, is joined by wire to the case of the electrometer, while it is made to surround but not to touch the Z piece with the burning substance placed on it.

Observations were made (1) when the cylinder was not surrounding the Z, and (2) when the cylinder was surrounding it. The results obtained when the cylinder was not surrounding the Z, though consistent as regards the sign of the electrification, are not

consistent in the magnitude of the electrification produced. It depends on the state of the electrification of the air of the room at the time. For example, when, by means of the water-dropper in the usual way, the potential of the air of the room was found to be  $1\frac{1}{2}$  volts negative, a burning paraffin lamp placed on the Z gave  $\frac{1}{2}$  volt positive, but when the water-dropper indicated that the potential of the air at its nozzle was 3 volts positive, the paraffin lamp on the Z gave  $1\frac{1}{2}$  volts positive. The results obtained with the copper cylinder surrounding the Z are, however, consistent in both these respects. For convenience of reference they are put in the following tabulated form :—

SUBSTANCE.	Electrification.	Magnitude of Electrification with the Cylinder.
Charcoal, - - - - -	Negative,	3 volts.
Lucifer match, wood, and paper, } glowing, - - - - - }	"	Same as charcoal.
Hydrogen, - - - - -	"	$\frac{1}{2}$ volt.
Iron burning in vapour of sulphur,	"	—
Copper, - - - - -	"	—
Paraffin lamp, - - - - -	Positive,	$\frac{1}{2}$ volt.
Alcohol lamp, - - - - -	"	$\frac{1}{3}$ to $\frac{1}{4}$ volt.
Sulphur, - - - - -	"	1 to 2 volts.
Phosphorus exposed to air, - -	"	$1\frac{1}{2}$ volts.
Magnesium, - - - - -	"	—
Iron burning in oxygen, - - -	"	—
Lucifer match, wood, and paper, } burning with flame, - - - }	"	—
Bisulphide of carbon, - - - -	"	$\frac{1}{7}$ to $\frac{3}{8}$ volt.
Sulphuric ether, - - - - -	"	$\frac{1}{8}$ to $\frac{1}{4}$ volt.
Turpentine, - - - - -	"	$\frac{1}{4}$ volt.
Bees' wax, - - - - -	"	$\frac{1}{4}$ volt.
Camphor, - - - - -	"	—

The effect of an ordinary lucifer match is very interesting. While the match is burning with a flame the deflection indicates positive electrification; but after the flame ceases the electrification becomes negative, the effect now being that of glowing charcoal.

At Fig. 5 there is shown the cylinder for screening the effect of surrounding air, which was used in the later experiments. It has a hole in the side which is covered with wire gauze, and through this wire gauze it is possible to see what is going on inside. Through the bottom of the cylinder passes an ebonite rod, supporting a metal disc, on which a small lamp is put (Fig. 6). This disc is connected to one of the terminals of the electrometer by a wire passing through the ebonite rod.

The arrangement for burning the substances in oxygen is shown at Fig. 7. The oxygen is made to pass in by A, and the burning substances are placed on G, a piece of platinum gauze which rests

on a wire bent into the form of a circle. Through the hole in the top it is possible to see how the substance inside is burning.

At Fig. 8 is shown the form of lamp specially made for volatile substances, such as sulphuric ether, bisulphide of carbon, &c. The stem is made of rolled platinum foil, and is nearly two inches long. A cotton thread was used as wick.

The arrangement for burning gases is represented by Fig. 9. B is a pointed glass tube connected to the ebonite tube, C. A fine platinum wire connected to the electrometer passes through the inside of the tubes and reaches to the flame. For hydrogen flame the end of the glass tube was protected by a small tube of platinum foil. Fig. 10 shows this arrangement surrounded by the cylinder ready for observation. To burn copper in vapour of sulphur, a quantity of sulphur was put into a wide test tube, and heated by means of a spirit lamp. When the test tube was full of the brown vapour, a spiral of copper wire connected to one of the terminals of the electrometer, and supported by an ebonite handle, was let down into the tube. The copper burned and the direction of the deflection was noted. The burning lasted so short a time that we were unable to make any quantitative determination.

An iron spiral let down in the same way did not burn; but we found that by immersing it in the sulphur while in a semi-fluid viscous condition, and afterwards applying a spirit flame to the spiral, it sometimes burned.

Our last results on the electrification of flames have led us to examine what is the state of different parts of the flame itself as regards electrification, and we hope later on to communicate to the Society the conclusions at which we have arrived.

It has been noticed that the positive lead of the electric-light wiring of Sir W. Thomson's electric installation is covered with dust, while the negative lead which runs alongside of it at a distance of a few inches is almost quite clean. These two leads were painted alike about 16 months ago. This fact confirms our observations, for the electrification of the inside of a room is generally negative, and hence the dust particles of the air would be more attracted to the positive lead.

It has been asked—Can air be electrified? or is the electrification observed due to the dust particles of the air? We see great difficulties in the way of deciding by a direct experiment, but we are devising arrangements which, we hope, will lead us to the correct answer.

III.—*Note on Nerve Cells.* By WILLIAM SNODGRASS, M.A., M.B.,  
Muirhead Demonstrator of Physiology, University of  
Glasgow.

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[Read before the Society, 5th February, 1890.]

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THE rapid advances made during the last quarter of a century in the science of histology—that is to say, in the science of microscopical anatomy—have been mainly due to two causes, namely, the vast improvement in the microscope as an optical instrument, and the discovery of better methods of preparing tissues for examination. No doubt, wonderfully good and accurate work was done before that, in spite of difficulties and drawbacks, and all the more credit is due to those who did so much with such defective apparatus. But modern instruments and methods of research have revealed structures which were formerly invisible, and disclosed organisation in parts that were formerly supposed to be amorphous and without structure.

Thus, for example, Schultze has been able to demonstrate the presence of fine fibrils in the axis cylinders or conducting parts of nerve fibres, and has been able to trace these fibrils into the nerve cells with which the nerve fibres are connected. But this fibrillation could at first only be seen by means of very high magnifying powers, and the fact of fibrillation in the living nerve is disputed by many at the present time. Few but specialists have sufficiently powerful microscopes, and many were deterred from studying the subject for themselves by difficulties of technique, by the want of appliances or of material, or by the idea that very elaborate processes have to be gone through before results of any value can be obtained. Still, the mode of connection of nerve fibres to nerve cells, and of nerve cells to one another, is to many a subject of deep interest.

So much is being done in the way of localisation of nerve function that we are eager to unravel the tangled threads of union of nerve centres to the periphery, and I may be pardoned if I venture to speak to-night of one or two methods by means of which even the most unpractised observer may, with the aid of a microscope of no great magnifying power, do much in the study

of these interesting points. For example, we may wish to study simply the form of nerve cells in the brain or spinal cord, and this may be done by the very easy method first introduced, I believe, by Thanhoffer of Vienna. Take a little piece of the grey matter of the brain or spinal cord, place it between two cover-glasses, and squeeze it till it has spread out into a fine film; then draw the two cover-glasses apart, and, grasping one of them with forceps, pass it through the flame of a spirit lamp or Bunsen burner till the film is scorched to a brown colour. The cells will retain their form, and may be seen standing out dark-brown in colour. In this way we may study the branching processes of multipolar cells in the spinal cord, or the pyramidal cells of the cerebrum, or the flask-shaped cells of the cerebellum. This method, of course, does not bring out the finer points of structure, but it shows form remarkably well. But fibrillation in the nerve cell and fibre may be readily demonstrated by a slight variation in the process. After the little bit of tissue has been squeezed out into a thin film, and the cover-glasses separated, the adherent film is allowed to dry (a process that may be hastened by heating), and then the cover-glass is immersed for a minute or so in a watery solution of one of the aniline or coal-tar dyes—preferably in methylene blue. The excess of colour is washed away with water, the glass dried, and the preparation mounted at once in xylol and Canada balsam. Several preparations made in this way may be seen to-night. You will see the multipolar cells of the spinal cord, one pole of which passes outwards, without branching, as the axis cylinder of the emerging nerve, while the other poles quickly branch and send off fibres to many centres through which the cells may be influenced. You may also see cells from the cerebrum and cerebellum similarly prepared. This method, however, is not the best if we wish to trace the poles to a considerable distance. Aniline blue-black serves better for this purpose; and you will see on the table a preparation of cells from the spinal cord of the ox, made by Carlier of Edinburgh, which shows this beautifully. There is also an interesting section of the spinal cord of the *Gymnotus electricus*, one of the electric fishes, which I brought over to Professor M'Kendrick from Professor Fritsch of Berlin. It shows a set of rounded cells in place of the ordinary motor multipolar nerve cells, and these cells have arisen from the ordinary motor cells, and have the power of giving rise to nerve currents, which in turn cause a discharge of electricity from the electrical organ of the fish.

By the kindness of Professor M'Kendrick, you may see to-night a very fine section of cerebrum prepared a long time ago by Lockhart Clarke, one of the specimens, I believe, upon which he based his description of the structure of the grey matter of the cerebrum.

Another section here shows an interesting point with regard to nerve cells, namely, the presence of pigment in them. In the course of examining a considerable number of nerve cells recently, I have been much struck with the almost invariable presence of pigment in them. No importance has hitherto, so far as I am aware, been attached to this; but it has occurred to me, looking to the work that has been done by Macmunn, Ray Lankester, and others in the pigments of animal and vegetable tissues, and to the important generalisation that many of these exercise a respiratory function, that it is possible that the pigment in nerve cells is not a waste substance, but an active agent in the cell life. It is well known that the molecular constitution of nerve cells is of a most complex character, that the cells are constantly undergoing metabolic changes of a constructive or destructive kind, and that these are mainly of the nature of oxidations or reductions. Probably it is the function of this pigment to assist in these processes, as the pigment of the retina may assist in the physico-chemical changes which give rise to the stimulus to the optic nerve and the sensation of light, or the histo-hæmatins may assist in transferring oxygen to the tissues. The point, at least, is worthy of further investigation, which may lead to interesting and valuable results.

The processes which I have mentioned as applicable to brain and spinal cord are not, however, sufficient if we wish to study the cells of ganglia, such as those in the posterior root of the spinal nerves, or in the sympathetic system. Here the cells are enclosed in a capsule of epithelial plates, and are bound to one another by such firm connective tissue that simple squeezing will not dissociate the cells. To study them it is better to tease out the ganglia in a drop of Müller's fluid (2.5 pot. bich., 1 sod. sulph., 100 water), then wash off excess of the reagent, stain with aniline blue-black, dry, and mount in balsam or dammar. Two specimens are shown prepared in this way from the rabbit's sympathetic ganglia. One of them shows the interesting point that many of these cells have two nuclei; the other, by its transverse marking at the part where the pole emerges, gives an indication of two poles passing out together, the one twisted spirally round the other.

IV.—*On the Relationships which the Perihelia of Comets bear to the Sun's Line of Flight in Space.* By HENRY MUIRHEAD, M.D., LL.D., Past-President of the Society.

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[Read before the Society, 5th February, 1890.]

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IN 1880 I read to the Society (see Vol. XIII., pp. 34-46) a paper, in which I touched, 1st, "On the connection seemingly existing between sun-spot maxima and minima and the relation which Jupiter in his orbital course bears to the Sun's line of flight in space as he progresses in the direction of helial longitude  $263^{\circ}\frac{1}{4}$ ;"\* 2nd, "On the connection of some of the phenomena exhibited by terrestrial magnetism with the relations which the three larger planets of the solar system bear to their primary in his onward movement in space;" 3rd, "On the arrangements which the perihelia of comets exhibit in relation to the Sun's line of flight." Now, although to our somewhat unheeding apprehension the sun, planets, and comets may seem to "have left in yonder silent sky no vestige where they flew," yet the cumulative evidence of these three sets of phenomena are of remarkable significance, and go to strengthen each other, both in regard to the importance of the relationships pointed out and of their meteorological influence.

It is not, however, my present purpose to dilate on this cumulative evidence, but merely to bring forward a few addenda to the facts formerly adduced in reference to cometic perihelia, so far as regards their relationship to the solar line of flight.

In my paper of 1880 I pointed out that, taking the two groups of comets given by Mr. Hind in his article "Comet," (Vol. VI., *Encycl. Brit.*), along with thirteen others, whose elements I was able to find in *Nature*, up to date—in all 35,—and arranging

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\* R.A.  $263^{\circ}\frac{1}{4}$  is the point assumed—after careful investigation—as the apex of the Sun's line of march in space, by the late R. A. Proctor in the article "Astronomy" in the second volume of the *Encycl. Brit.*; and although some other astronomers may differ a little from his conclusion, I have not thought any other point sufficiently established to induce me to change said apex.—H.M.

them circularly according to their heliocentric longitudes, the perihelia were obviously enough seen to be largely crowded into the quadrants which the Sun's line of flight bisects, as compared with those taking place in the quadrants flanking the said line. (See Plate V. in Volume XIII. of our *Proceedings*.)

Quite recently I have examined the succeeding volumes of *Nature*, noting all the comets whose elements are therein recorded. By means thereof I have been able to get at the heliocentric longitudes of the perihelia of 41 more, making a total of 76.

REFERENCE LIST OF THE 41 COMETS RECENTLY FOUND MENTIONED  
IN THE PAGES OF *NATURE*.

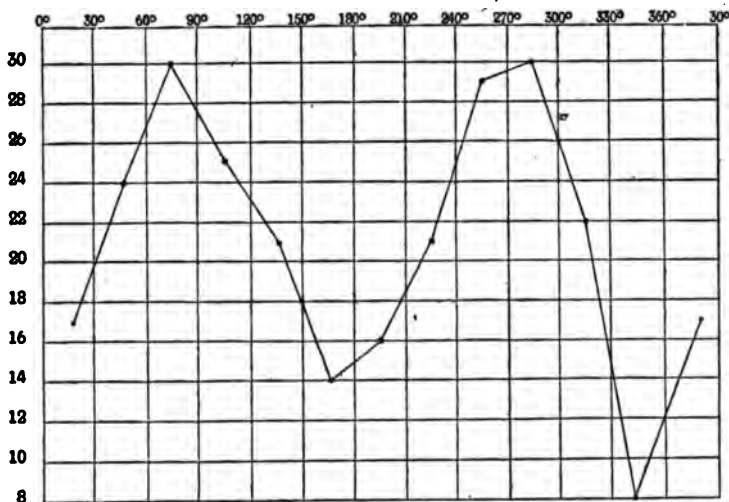
		°	'	"		VOL.	PAGE.
14	1st Comet of 1798, ...	105	5	43	... 1798	29	135
15	Messier of 1771, ...	104	1	21	... 1771	27	374
16	Pons's, ...	63	44	0	... 1810	24	111
17	Respighi's, ...	60	24	0	... 1863	24	111
18	Swift's ...	297	55	0	... 1881	24	65
19	Tebbut's, ...	265	9	4	... 1881	24	248
20	Schaberle's, ...	334	44	0	... 1881	24	342
21	Barnard's, ...	250	4	0	... 1881	24	541
22	Denning's, ...	312	0	0	... 1881	25	414
23	Wells', ...	53	55	0	... 1882	26	114
24	Finlay's, ...	276	47	0	... 1882	26	636
25	Comet, A, ...	33	24	0	... 1883	27	445
26	Ross's or Scott's, ...	125	44	0	... 1884	29	606
27	Tuttle's, ...	200	46	0	... 1884	30	83
28	Barnard's, ...	306	7	0	... 1884	30	546
29	Wolf's, ...	19	21	0	... 1884	30	615
30	Brooks's, ...	43	0	47	... 1884	32	543
31	Fabry's, ...	126	50	28	... 1885	33	426
32	Barnard's, ...	118	57	10	... 1885	33	236
33	Brooks's, ...	296	38	45	... 1885	33	279
34	I. Brooks's, ...	202	56	0	... 1886	34	40
35	II. ,, ...	37	50	15	... 1866	34	40
36	III. ,, ...	229	45	48	... 1886	34	436
37	Barnard's, ...	78	56	20	... 1886	34	603
38	Great South, ...	63	36	7	... 1887	35	185
39	Brooks's, ...	89	26	17	... 1887	35	352
40	Barnard's, ...	284	27	58	... 1887	35	352
41	Barnard's, ...	36	37	0	... 1887	35	446
42	Barnard's, ...	15	40	19	... 1887	36	138
43	Brooks's, ...	72	9	7	... 1887	36	478
44	Sawerthal's, ...	359	49	45	... 1888	37	597
45	Brooks's, ...	59	19	2	... 1888	38	503
46	Barnard's, ...	65	0	12	... 1888	39	61

			°	'	"		VOL.	PAGE
47	Barnard's,	...	340	28	0	...	1889	39 ... 211
48	Barnard's,	...	257	27	28	...	1889	39 ... 591
49	Barnard's,	...	75	19	5	...	1889	40 ... 255
50	Brooks's,	...	330	37	0	...	1889	40 ... 424
51	Davidson's,	...	345	53	0	...	1889	40 ... 424
52	Brooks's,	...	341	56	0	...	1889	40 ... 551
53	Swift's,	...	309	51	12	...	1889	41 ... 115
54	Borelli's,	...	211	4	23	...	1889	41 ... 211

These 41 I find to exhibit the same remarkable tendency to avoid the perpendiculars to the solar line of flight. This relative paucity of cometic perihelia is more especially exhibited in the flank quadrant extending from  $130^\circ$  to  $220^\circ$ , in which division I have been only able to find eight occurring out of a total of 76, whereas, had the helial turning-points been uniformly distributed, there should have been 20. It is, however, proper to notice that as many as four new cometic perihelia took place in the opposite flank quadrant during the latter half of last year—after my paper had been sent to the Organising Committee of the British Association for judgment.\*

Moreover, in Guillemin's "World of Comets" (page 186 of Glaisher's translation), we are furnished with a table, given

DIAGRAM OF LONGITUDES OF PERHELIA OF 257 COMETS.



\* Last September the present paper was read in Section A at the Newcastle Meeting of the British Association for the Advancement of Science. An abstract appears in *British Association Report* for 1889, p. 488.

below, of 257 cometic perihelia. In this table in the sixty degrees intervening between  $150^\circ$  and  $210^\circ$  forming the sinister flank division (of the plate at page 42, Vol. XIII.) we have the numbers  $14 + 16 = 30$ , and between  $330^\circ$  and  $30^\circ$  in the dexter flank division  $8 + 17 = 25$ , making a total of 55. Well, neglecting the intermediate twelfths, which show a remarkable intermediate character—namely, 24, 21, 21, 22,—let us now take those numbers in the quadrants which the sun's line of flight bisects. Those between  $60^\circ$  and  $120^\circ$  are  $30 + 25 = 55$ , and those between  $240^\circ$  and  $300^\circ$  are  $29 + 30 = 59$ : for both, 114, or more than double of those of the flank divisions. Had I been able to obtain much smaller segments of the circle than 60 degrees, the differences or contrast would likely have been much more striking. The diagram on the previous page shows *graphically* the numerical differences of the perihelia occurring in the flank and bisected divisions.

Beyond referring to the suggestions offered at page 43 of my paper of 1880, I offer no further comment than to ask "Is it likely that our Sun's primary is situated to the dexter side of the line of flight drawn in Plate V.?" For, seeing that there occurs such a remarkable paucity—eight only occurring in the sinister side,—we are tempted to presume that comets travelling towards the opposite or dexter side may perhaps occasionally journey so far as to get within the influence of the larger body or its outliers, and so get captured and detained, "or others prevented passing by," since, if coming from empty space on the far side, the primary is not likely to let them (the comets) go on to its tributary the Sun.

TABLE FROM GUILLEMIN'S "WORLD OF COMETS."

Longitudes of Perihelia comprised between		Numbers of Perihelia of Comets.	
0°	and 30°	...	— 17
30	„ 60	...	24
60	„ 90	...	+ 30
90	„ 120	...	+ 25
120	„ 150	...	21
150	„ 180	...	— 14
180	„ 210	...	— 16
210	„ 240	...	21
240	„ 270	...	+ 29
270	„ 300	...	+ 30
300	„ 330	...	22
330	„ 360	...	— 8

The divisions bisected by the line of flight I have marked thus +, the flank numbers thus —, the intermediate being left unmarked.

V.—*On Fiji: Past and Present.* By JAMES BLYTH, late  
Secretary for Native Affairs in Fiji.

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[Communicated to the Geographical and Ethnological Section by  
Mr. Robert Blyth, C.A., 28th April, 1890.]

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By the word "past" nothing very remote is intended. The Fijians have no written history. Their knowledge of the past is limited to what their *ngases* (ngases), their old men, have told them of *na gauna makāwa* (*na ngauna makāwa*), the old times. There are no words in this connection more frequently on their lips than these "*na gauna makāwa*." What was done in the old times by their elders is always quoted as a precedent for everything done in the present, and they invariably speak of the old times and the old men with respect, and even with reverence, as their authorities. The past to them in this sense is a period of about fifty years ago or more, and it might be interesting to consider that past, when as yet there was in the beginning of the century no European settlement in the group; when the islands were visited by whalers only, or later by traders for sandalwood and *bêche-de-mer*; or it might be instructive to regard the "past" of fifty years ago, when Christianity was first introduced—for it is only three years since the missionaries held their jubilee.

Fifty years ago the natives of Fiji were in what is called "the darkness of heathenism," and the "light of the Gospel" came to them from the neighbouring group of islands called Tonga or the Friendly Isles; but, though the progress made from the first was great, the area that had become "*lotu*," or Christian, was small during the first twenty years; after that the advance was more rapid. For the purpose of this paper the past may mean the period prior to the last quarter of a century, or thirty years ago. The year 1865 is an important one in Fiji history. It was then that the *tovata* or confederation was formed—a union of three or more of the most powerful chiefdoms for their defence, and also for the better promulgation of the new laws of civilised life. The *tovata* was the offspring of European influence, which

was then being felt commonly everywhere throughout the group, and also of Tongan influence, which had been increasing steadily for many years.

The time when Tongans made their first appearance in Fiji is matter of conjecture; probably it was two hundred years before or more, but in 1860 they had already made many conquests. Their ascendancy in the Windward Isles was established, and on all the coasts of the larger islands, and on many of the smaller ones also, the two races had begun to intermingle and intermarry. It may here be mentioned, in passing, that about this time the power of the Chief of Bau, the most influential family in Fiji, if not actually waning, was no longer crescent, and that his rival Maäfu, the Tongan, was gradually but surely crippling him everywhere, till about fifteen years after, or in 1874, Cakobau (*Thakombau*), no longer able to cope with the new power of Maäfu, ceded the islands to Great Britain to save their being seized by the Tongan, who would soon have reduced the people to servitude.

These Tongans loom largely in the recent history of Fiji. Their influence frequently was for good. They were largely instrumental in the introduction of the lotu. It would be false to say that the lotu was propagated like Mohammedanism, but it would be true to assert that coercion was often used. Macuāta (*Mathwata*) "lotu'd" about this time, and their acceptance of the lotu was a condition of peace after what is called the Tongan war there in 1860. And, as a further example of what I have called coercion, I may cite the island of Waia, which also at this time, or very shortly afterwards, "lotu'd." The form which coercion took, and the necessity which there was for it in this case, will appear when I state that Waia is the most southerly of the Yasawa group, separated by only half-a-mile of sea; and when all the other islands, some six or seven, of that group had "lotu'd," Waia remained wild and untractable. Any boat or canoe that was wrecked there was immediately seized, and the occupants were murdered. The Waia people were therefore a thorn in the side of the Yasawans, and war was made on them. After a brief struggle they were overcome and removed altogether to the other islands, where they were retained until they accepted the lotu. They were then taken back to their island, and became respectable members of society. They also began then to participate in the benefits of the *present*, and we proceed now

to consider the Fijians prior to this period in the *past* of thirty years ago.

There were then three or four puissant chiefs in the group. Verāta had had its day. It had been great, and Rewa, its neighbour, had in its turn become great; but both had succumbed to the intrigues of the son of Tanoa at Bau (*Mbau*), who afterwards took the name of Cakobau, and became the "G.O.M." of annexation. The manifestations of Bau's policy were felt throughout every part of Fiji. The power of Bau was felt, though not acknowledged, everywhere. And it was when Bau "lotu'd" just previous to this time (1854, I think) that the missionaries' triumphs were greatest. In the east, Maāfu was all-powerful; in the north-east, Tui Cakau (*Tui Thakau*) was supreme; in the north-west, the pirate Ritova held sway; and to these may be added Tui Bua, and Bua, whose father had been only a small chief, but who, with the assistance of the Tongans (himself of Tongan extraction), and of an able European secretary, had raised his lands to the dignity of a so-called kingdom. There were many other famous men and men of renown at this time in the different islands, but those mentioned were the most powerful, and they were always at war amongst themselves, or conspiring against others.

War thirty years ago was not an exceptional state of things, and there was little about it that was noble. We speak of "the pomp and circumstance of war," and when victorious one speaks of its "glory." But among the Fijians, although there were deeds of individual valour recorded, there was very much about it that was ignoble and mean. Not only is war inseparably associated in Fiji with intrigue and treachery to the last degree, but there was often an unfairness about it which must be condemned. Too often some unfortunate tribe, who, in their isolation, had become proud and arrogant and had defied the sovereign chief, found that they had to fight not that chief only but all his allies, and ultimately it resolved itself into this, that the chief who was keenest at intrigue and secured the greatest number of allies was victorious. Bravery in those days was no shield to treachery. The numbers killed in these wars were not as a rule great, and the reason is obvious. The *land* in Fiji belongs to the people, not to the chief; the *people* belong to the chief. A chief, therefore, did not make war for land alone, irrespective of the people on it, and the more people he killed in war the more by consequence he

weakened his own power. The more people the more power. The more people, also, the more service of food and manufacture; for, though often at war, there were times of peace, and the greatness of a chief was shown in times of peace as well as in times of war.

One is apt, in reading many histories, to suppose that they record times of turmoil only and struggles for life, but we find that industries have been going on all the time, the duties of every-day life have been attended to, and there were times, even in the darkest days, of quiet and rest somewhere. And so it was in Fiji. The old men still speak with kindling eyes of the "good old times"—the times we call the "past"—when there were feasts such as could not be produced in these (to them, of course) degenerate days.

It was usual in times past, as well as in times present, to have great meetings for the exchange of their goods or property. This is called the "solévu." Sometimes a village will solévu to another village, or one tribe will solévu to another. The object is at all times friendly, and sometimes an immense concourse of people will take part in them. A great solévu is *the* event of the year and the place. Preparations are made beforehand for months or years. Not only are the various articles to be exchanged got ready, but quantities of food have to be prepared and animal food provided, which with Fijians is pig chiefly; and where chiefs are concerned turtle, and in some places fish, dried and smoked, and fowls are added. These feasts may extend over several days, and the days and nights are not unfrequently too short for the amusements provided, consisting for the most part of dancing (*mekemeke*) by the men, and also by the women, and other games. Usually a dance accompanied or preceded the exchange of property, but not always. Various villages or tribes had their own specialty in the way of production. In one place they made pottery, and in another nets for fishing, in another different kinds of native cloth, in another baskets and fans, in another house mats or sail mats, in another canoes, and in another the sole marketable product brought was manufactured *salt*, and so on.

These solévus were conducted with the utmost fairness. During these times there was joy in the land. Probably in all the world the sun did not shine upon a happier people, nor the night fall on better regulated villages. For in time past the Fijian was highly civilised. True it is that he was treacherous and bloodthirsty at

times, and his name has become a proverb in the so-called civilised world. But the Fijian had a civilisation, of a kind, of his own. His language shows it, being copious, expressive, refined. And of all things, the Fijian is pre-eminently rigorous in all matters of etiquette.

No people are more punctilious in the observance of ceremony. Ceremonies attend upon everything—the building of a house, the planting of a garden, the cutting of timber, the construction of canoes, the fishing for turtle;—every service rendered by the people to the chief is accompanied by some ceremony, involving return presents of some kind or in some shape. And all the incidents of domestic life are surrounded by ceremony—births, and all stages of life from infancy to manhood. Even before the child is born there are ceremonies to be performed, and these are never omitted. There are ceremonies at marriage—and generally presentations with all these ceremonies of property, and ceremonies at death. All these are notes of civilisation. But their civilisation was not ours. It is customary with us to say that the place accorded by man to woman in his society is a gauge of the civilisation of that society; and, tried by this standard, the civilisation of the Fijian shows to a disadvantage. Amongst the common people particularly, the woman was the drudge; as a rule, if there was a heavy weight to carry she had to carry it. In some parts of Fiji the women took their share in the hard work of the fields; but in other parts, especially in those influenced by Tongan example (for the Tongans did not exact hard labour from their women), the women never went near the food plantations either to plant or dig food. Still, even in these more favoured parts of Fiji the women were the hewers of wood, or more correctly, the collectors of firewood, and the drawers of water. The chiefs, on the other hand, treated their ladies (*marama*) well. Their wives were of as high rank as themselves, and it might have caused serious complications with the families or tribes to which they belonged if the ladies had been ill-used or degraded to menial work. It was necessary that a chief, if he were ambitious to form a good connection, should ally himself to a powerful tribe. This will appear more clearly when I refer briefly to the custom among these islanders called “*vasu*,” or the right of the nephew to appropriate anything in his uncle’s house that took his fancy. The importance of a *vasu* in time of peace was great, and it was great also in time of war. There was no limit to the good or ill he might do beyond custom, which

regulated everything, and a vasu who abused his power soon found his level accordingly. The vasu, I repeat, could enter his uncle's land, and go into any of his villages, and take anything from his uncle's people that his uncle himself could have claimed. The people always recognised the right of the vasu through his mother. There was therefore a rivalry to secure high-born ladies from other tribes for their chiefs' sons, in order that they might make reprisals and attain power and privilege. The way in which these ladies were treated was a note also of the civilisation of the time. As a rule the chief was kind to the common women of his household, in whatsoever capacity they served him. The Fiji chief of those days was often a true gentleman—kind, considerate for others, courteous to all, of unbounded hospitality,—in a word, the father of his people, and often looked upon also as their god. In those old days the chief might truly become their god in process of time and after his death, if in life he had been their hero and had led them to victory and plunder. The religion of the old days was worship of ancestry. The warrior of to-day became the object of reverence in the future, and he was regarded as amongst the gods, but even during his lifetime he was often esteemed by the common people as little less than a god.

There were, of course, bad chiefs as well as good chiefs, and some of the chiefs in times past were very bad indeed. The ambition of a bad man was to "rogo" (*rongo*), that is to say, to "get his name up"—to do something so very bad that the ears of all should tingle when they heard it, and that he should be feared above all his contemporaries. Well did all the chiefs, good and bad, know that fear was the power alone by which they held the people in check. The very best of the Fiji chiefs was absolutely inexorable during war times, and in times of peace he lived upon his acquired renown. In times past there was a hush in the village when the chief drank "yagona" (*yannгона*), or "kava," as the Tongans call it; there was a hush when he ate or slept—and it was the hush of fear. Club law prevailed, and a man was often clubbed for mere breaches of etiquette—an etiquette so various and with such ramifications that the mere mention of the matters affected would occupy too much time. But, in one word—to conclude the "past,"—the past times were severe and cruel, but there was great order and discipline maintained, and life, under the better sort of chiefs, at any rate, was such that the old men could speak of them as the good old times—as times of wisdom, of sagacity, of energy

in war and enterprise in peace;—good, as they say, for *those* times, and good in some respects, though not in all, for imitation in the present.

Coming now to *present* times. What shall I say first? Alas! all the old chiefs have passed away! Not one remains—the last, and one of the best, Tui Bua, died only a few months ago. There are now no chiefs in Fiji like the old chiefs. There are good men still, but, as they themselves say in council, “we are but children in wisdom compared with our fathers, the old men.” Their lives have not been moulded in the same stern battlefield. All their days they have been sheltered from rough blasts, and they have not the self-reliance and conscious power of their fathers. They have more knowledge, perhaps, but oftentimes less wisdom. They have no longer the same incentives to energy or an energetic life. They have other incentives, it is true—what many would call higher incentives; but whether or not the higher will be equally or more operative remains to be seen, for the problem is not yet worked out. So far, the present policy is working well, every allowance being made, and the future alone can declare the result. I have not seen the statistics of the population for the last year, but up till then there was little variation from year to year. Some years, since annexation, there has been a slight increase of births over deaths; and then again in other years an epidemic has visited the shores, and that margin has been swept away, and a loss greater or less recorded. I should think that, on the whole, there has been a loss of three thousand, or about that number, since 1875, and that loss was sustained chiefly in one year from whooping-cough. For it is to be noted that when any complaint of that kind makes its appearance for the first time the mortality is always greater than on any subsequent occasion, and it may be that the Fijian will suffer less in future from European epidemic than he has done hitherto. It will be within the memory of all that during 1874, or the period between the past and present, about the time of the annexation of the islands (a little before it), measles was brought in from Sydney, and to it one-fourth of the entire population succumbed. The deaths were reckoned at forty thousand. This makes a great gap between the different parts of my subject. It is certainly the most melancholy thing to be recorded in the history of the present.

We have seen briefly what the Fijian chiefs and people were; let us now endeavour to see them as they are. And first, in their

relations to their lands and to all their manners and customs and rules of precedent there is no change, except in so far as they themselves require to adapt their conduct to the new surroundings, consequent upon contact with strangers and their communication with the outside world. The people still hold all the land, except such portions of it as they themselves had alienated previous to annexation, and which has been confirmed to the purchaser by His Excellency the Governor, after due investigations. The present policy is based on the old policy. All the regulations that have been made for the conduct of life and business amongst the natives are founded on native precedent, so far as is possible, as aforesaid. The rails have been laid down on the old ways, and it remains to be seen whether or not the natives will avail themselves of them fully.

In the past the Fijians had their courts and councils, and they have them still, with such modifications only as their higher status requires. In times past they had courts in which the old men were judges; now they have native courts presided over by one of themselves—a native magistrate for the hearing of trivial cases, and called a District Court; and they have a higher court, presided over by a European and native magistrate, to which there is an appeal from the district court. This is called the Provincial Court, to which graver cases are brought, as provided by law. They have also councils, as in times past. These councils are called “Bose” (*Mbose*), or meetings for the purpose of deliberating on various matters of more or less importance. As in times past of the old country everything is done by public meeting, so in Fiji everything is done by the bōse. There are bōses of all kinds. The women can have their own bōse, in which they decide and determine what is *their* part in any function. It may be they have to decide what food they have to prepare, or it may be that they have to determine what property they shall give at any festival; but they always meet and do their work conscientiously and well.

The bōses among the men which are recognised by law are four. The “Bose-ni-Koro”—that is to say, of the village presided over by the Turanga-ni-Koro, or chief of the town, in which everything connected with the village is discussed—deals with the keeping clear of the roads, the conservation of the wells, the burial-places, the disposal of the refuse, the village rates, and so forth; and even in these simple meetings all due ceremony is observed. Food is prepared, and sometimes little presents are

made, and the speakers observe all the forms of large assemblies. The second is called the "Bose-ni-Tikina," or District Council, presided over by the Buli, or head of the district. This council meets once every month, and is attended by the chiefs of all towns or villages, and by the "gases," or old men, also by the Turanga-ni-Matagali (*Matannkali*), or heads of families. They discuss the larger subjects of the district—the state of each village, of the roads, plantations (private and public) of the people, the births and deaths, the state of the sick or the infirm, the schools—and so forth. They also have their feast, and the food having been prepared in common, divided and eaten in common, serves still further to strengthen the common bond. The third council is called "Bose-ni-Yasána," or Provincial Council, which meets once every six months, in January and July, and is presided over by the Roko Tui, or chief of the province. It is attended by his Excellency's Native Commissioner. All the bulis, or heads of districts, are severally called upon to make a report of their districts, and the most searching inquiry is made into all matters connected with the province. All the chiefs of villages attend, and also the magistrates, and a report of the meeting is submitted to the governor. The fourth council is called the "Bose-ni-Turanga," or Council of Chiefs. It meets once a year, and is opened and closed by the governor in person. It is attended by all the chiefs of the provinces called Roko Tui, two of the heads of districts, the magistrates, and such of the chiefs of towns and others as are invited. It discusses all the native affairs of the country, and especially such subjects as are submitted to it by the governor. The Native Commissioner presides, and it is his duty to present to the governor all the resolutions which the council has drawn up. At the council of chiefs any one present can speak, but the Roko Tuis only can vote—aye or nay. The ceremonies in connection with it are *de rigueur*. Everything, down to the most trifling minutiae, is the subject of ceremony. The food is on a sumptuous scale, and is presented every day with every polite observance required by the etiquette of the chiefs. After the discussions are over, there is dancing with an interpresentation of property, as at solévus. The quantity of food prepared, and the number and sumptuousness of the presents offered on these occasions, are matters of wonder to strangers, but as everything is conducted by the Mata-ni-Vanúa, or recognised masters of

ceremonies, there is never any hitch, and even the most complicated functions move off easily.

The council over, chiefs and people return to their homes. The business of the year is done in one sense: in another it has just begun. On their return, the chiefs explain to their people who have not attended at the council all that has been done, especially any new laws or regulations that have been passed. Then there are the plantations to attend to, public and private. The public plantations may be of maize, or of tobacco, or of cocoa-nut, or such like, by means of which that province pays its tax to the government; for the tax is assessed by provinces, and the chief, with the aid of a European sometimes, decides what the tax shall be paid in, and is himself responsible for the amount assessed by the governor in council. The private plantations are also managed in the same way. All the people join together in planting the chiefs' gardens, and then they continue, day by day, until all the plantations are finished, to plant gardens for every family. The community does everything; the individual is not recognised in anything.

The unit in Fiji is the "matagali" (*matanngali*), or family. If a chief arrives in a village, or a stranger, be he European or native, the community provides the food for his entertainment, every family in the village giving its quota. If any house has to be built, the community do it, and the owner provides the feast—that is to say, the owner and his friends, for the owner *as an individual* (save criminally) has no existence, and when the planting is done, what remains?

For chiefs and people there is always plenty to do, even in government work alone—preparing after one council for the next, looking after the welfare of the community, the roads, woods, and forests, and all such work. For, be it observed, every native of Fiji is a landowner. There is no land in the group that has not an owner, and every bit of land has a name. There are, indeed, lands, and lands. Some lands are called "koro," or villages, because they are, or have been, the site of a house or houses, and these belong to families. A family has a site in a village; it is theirs to occupy, not to alienate by sale or otherwise. There is another class or category of land in the neighbourhood of the village on which the family plant: it is theirs to plant on. And there is a third category of land, farther afield, on which the tribe plants in common, any family or head of a family selecting what

portion of it may be thought most suitable. If it is under bush or scrub he clears it, and it is his to plant on for that year and the next year or more for succeeding crops in rotation. A native never plants the same land with the same crop twice in succession. It may lie fallow, or change its crop, say, from yams to bananas, as is often done. It would not be easy to teach a native anything in the way of planting native food. He understands all that thoroughly, and does it well. He tends his yam garden as a mother tends her babe, watching over it with the tenderest solicitude. His garden is his life; all his thoughts are for it. When he is away from it, it is never long absent from his mind.

“Still o’er these scenes his memory wakes,  
And fondly broods with miser care.”

Sometimes at a “bose” perhaps he will be in a brown study, and when aroused he will say quite naturally—“sa vināka na uca, sa bula na kawai” (the rain is good, the sweet potatoes will benefit by it), or some other simple remark about his plantations. Every man and boy, generally speaking, plants. The chiefs, theoretically, are the best planters. They ought to do everything better than every commoner, and most frequently, or very often, they do. Anyone who is willing can find land to plant on.

Not long ago one of the European magistrates was conversing with a number of men in a native house at night; whiling away the time, in fact, as is not unusual (for the natives are eager listeners), telling tales of the white people at home, of wonderful things, underground railways, balloons, and such like. Presently he talked of London, its size and wealth, and still the people listened quietly. It was all right—London was no doubt a big place, and the people were rich. Then the narrator went on to say—“Yes, and in that great and rich city there are hundreds of thousands of poor people, people so poor that they know not at night where they will get their breakfast in the morning.” This was too much. The chief said “Come, come! we believe all you say about the underground railways and the balloons, but if you tell us there are people in London who have no land of their own to plant on, or cannot get any by asking the chief, that is too much—it cannot be. God always provides land for every man born into the world.” That is just what the chief said, and that is just what the Fijian thinks. The Fijian has always plenty to do in his garden, but still all that is duty work, and the Fijian

does miss the excitements and incitements of the old times. And now I anticipate some questions. For example—"Is the *vasu* allowed still?" Yes, to some extent. A *vasu* may appropriate still what he likes *if the people consent*, but not unless they do. The *vasu* has no longer any property in his uncle as of *right*; he may exercise his privilege by courtesy only. If he attempts to enforce a claim, it is a case for the courts of law, and any native can recover in court for any damage he may have sustained at the hand of the *vasu*. It may be asked further—"Can the chief now oppress his people?" I answer "No." He has claims on them, *as chief*, for certain services; but these services are well understood both by chiefs and by people, and if a chief oversteps the bounds of law and custom, and takes from a commoner or community anything to which he is not entitled of right, the law protects the wronged person or community. The chief cannot, for example, take money from a commoner against his will, or by undue influence, without risk of being called to account for it; for although all things are still held in common the commoners' rights also are respected.

Again, it may be asked, "Is the tone of civilisation higher in the present than in the past?" In other words, "Is the position of woman improved?" I think, on the whole, that it is. In times past no husband ever lived under the same roof as his wife, he never at all events slept under the same roof. Now husband and wife often do live together. Formerly all the unmarried women lived in one house, and all the unmarried men in another; now families in some cases live together, and chiefs have been seen even to *eat* with their wives at the same time and at the same table. But that civilisation has not yet reached the highest point in this respect may be gathered from the following story:—A few years ago a magistrate was being rowed down a river in a down-pour of rain. Looking out, he saw what he thought was an umbrella on some approaching craft, but the rain was too heavy to admit of anything being distinguished. Presently, however, on coming abreast of it, a raft was visible, made of bamboos. On the raft was an empty gin box of the red-wood type, and on the box sat a native holding the umbrella. The raft appeared to be moving up stream, and yet no one was poling it or pulling it along the bank. After a minute inspection the magistrate discovered a small black speck on the river about a fathom ahead of the raft. This proved to be the head of a woman. She was striking out

nobly with her right hand, and through her teeth was a rope fixed to the raft and held by her left hand. She was, in fact, dragging the raft up the river, swimming the while as only a native can swim. This woman was the wife of that man.

Finally, and not to make this paper too long, it may be asked, "Are the chiefs and people as happy in the present as they were in the past?" To this it might be replied that after all a man finds his happiness, or ought to find it, in the discharge of his duties; but, waiving this point, it will be better to give the answer of Tui Bua, one of the best and wisest of the chiefs, as I have said, when he was asked the question. Said he—"Only those who have been harassed by war know the real blessings of peace. Often in times past when I lay down to sleep, I knew not at what moment a messenger might arrive with a whale's tooth and a challenge to war. I knew not any night but what I should have to arise and defend my house, my wife, and my children. But now we feel that there is a strong arm around us. We lie down in quiet and we rise up in security. All this comes from the goodness of our Lady the Queen and her Government, and from the love of God, who is our Father." It would be easy, in comparing the present with the past in Fiji, to present a picture in extreme light and shade; it might produce a sensational contrast, but it would probably give a false idea of the people. It is true they had their war times—times of frenzy; but to think of a Fijian as commonly frenzied and bloodthirsty is a false conception of him. No more beautiful village could be seen at times, and no more industrious people in all God's fair world. At their worst they were indeed bad; there are no such extremes now. Christianity has been like oil on a troubled sea; the waves of disquietude are at rest for ever. The Wesleyan Mission has done its work well. Fiji was favoured in her missionaries. They were genuine good men and women—some of them in the early days amongst the noblest of human kind. The organisation of the mission is perfect. In these days a different class of men is wanted, and a different class is there. The record of the Wesleyan Mission is very instructive reading. It is not quarter of a century since the last cannibal feast was spread (there was cannibalism in the mountains, indeed, so late as 1876, but that was an isolated case), and in what I have called the "past" of Fiji the land was too often filled with the shouts of ensanguined multitudes: "tumultuous horror shook the midnight air" where now all is peace. There is a hush

over all, and it is not now the hush of fear. One fact explains all. Every morning at sunrise, and every evening shortly after the sun sets, a stranger passing through any village in Fiji will hear the voice of praise and prayer from almost every house. There is hardly a native family throughout the length and breadth of this land where there is not worship morning and evening every day in the year.

VI.—On Some Consideration of *Asia Minor and its Ethnology*.

By Rev. HUGH CALLAN, M.A.

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[Read before the Geographical and Ethnological Section, 28th April, 1890.]

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WHY is the peninsula of Asia Minor peculiarly interesting? It is so for many and varied reasons. Its position as the last step towards Europe of that great stair of levels leading down from Central Asia—the source of peoples and of languages—is the main reason, and the others depend upon that. Here Asia met Europe, and first burst into the clear light of history. I give some of the other causes of interest:—

(1) It was the birthplace of epic poetry; for whether Homer belonged to about Troy or not, the Troad is there which gave him his subject. It was also the birthplace of true history; for Herodotus, the father of history, was an Ionian (of Halicarnassus). It was also the home of the earlier Greek philosophers.

(2) It has been the scene of some of the notablest military expeditions: Xerxes and Darius passed through it to overwhelm the Greeks, and be chased back; through it Cyrus and his Greek mercenaries marched to fight the “Great King” at Cunaxa; and thence Xenophon led the famous retreat of the 10,000. On its Plain of Issus in Cilicia, at the easternmost corner, Alexander the Great met Darius and his Persian hordes, and decided the supremacy of the Greek in the world.

(3) It was the scene of the first great Christian missionary enterprise, when Paul carried the Gospel to this, his native, land, and thence to Europe.

(4) It has been the battleground of the west against the east, whether we regard the Greeks against the Persians, or the many passages of the Crusades, or the Greek Byzantine Emperors struggling in vain against the successive waves of Moslem tribes: it is the Belgium of Asia.

(5) Because there, if anywhere, are being decided the comparative merits of the Crescent and the Cross—as to which, in the eyes of the world and in the sure mills of Providence, is the best

workable religion for human life; and more than that, all questions of morals and social organisation depending on the one or the other religion, such as the condition of women (monogamy or polygamy, drudgery or companionship), social intercourse, style of living, dress, letters, and arts; for such questions, as for almost every question, Asia Minor is the point of meeting and contest between western and eastern ideas. There is little doubt that the customs at present prevalent over it were introduced by the hosts from the far east, and when, finally, Islam prevailed, the Greeks and Armenians and other Christians were forced to give up their own ways of living, even though they retained their faith. But the same process is now going on the other way quite perceptibly all over Turkey; the forms and practices and ideas of western and Christian life are changing, or fusing, with those of the east.

(6) Another cause of interest, which is not so patent to the public mind, is the extraordinary variety of races living there in the same provinces, and even in the same communities, differing widely in religion, language, and race. Thus Asia Minor has an exceptionally general interest.

It has claims on the attention of the *merchant* — for, in spite of utter neglect and no system, it is still one of the most fertile countries, both in fauna and flora. Among its mountains, as in the Olympus range and in Cilicia Tracheia, the valleys are prolific of all grains and fruits, and green perennially, even in drought. Immense forests clothe the hillsides with oak, pines, ilex, arbutus, and the majestic plane. Its plains, which are numerous and enormous, are covered with the finest soil, which, although scratched merely with the rudest implements, gives a rich harvest; and all over the country the traveller looks with astonishment at the mere patches under cultivation compared with what is not. There is no lack of water, except on the great treeless (Axylos) plain, for the mountain ranges everywhere send down abundant streams, which, in many parts, form great lakes or chains of little lakes or immense marshes. There is, for example, the great plateau reaching from Kutaya to near Kaisariyeh, 250 by 100 miles, shut in all round by the Bulgar Dagh, the Sultan Dagh, and the Taurus ridge to the south (7,000 to 13,000 feet), and by the Emin Dagh, Hassan Dagh, and Ergish Dagh (11,800 feet) (Argaeus) to the north, forming a sort of basin whence there is no outlet for the waters, which form the lakes of Tuzgheul (Salt Lake), of Konia, Aksheher, Bulwudun, Egerdir, &c., and great

tracts of marsh land, all which, if properly regulated, drained, or used for irrigation, would undoubtedly cause the land to yield like the Nile Valley. Sir Charles Wilson says he never saw even in America such wheat lands, and he did not, I think, go over half the ground that I covered; and these at present are a mere pasture for the Karaman sheep and the mohair goat of Angora. There is scarcely any wheat grown—only a little barley; but madder and opium are grown in many spots and exported in great quantities, and tobacco nearly everywhere, which the government *Régie Monopole* has well in hand. I can but mention the gum tragacanth—so scarce at present—found in abundance on the mountains between Cæsarea and Tarsus, the salt lakes yielding salt inexhaustibly, the lead and silver mines of Cilicia (and the tradition of gold ones), the meerscham mines of Eskishehr, the oil and petroleum wells of the north coast, and the suspected untapped wealth of other mineral products. With many large rivers (the Halys, Sakaria, Meander, &c.) fit to be made navigable, and everywhere beautiful bays for harbours, all that is needed is the railway up the interior, and the introduction of western appliances. I have a letter from an eminent London engineer in which his expressed chagrin at losing the railway concession amply proves that he knew what his company has missed.

Lesser Asia has peculiar claims on the attention of the *geographer*, because it is in reality as well as in name a miniature of the whole continent of Asia: the same plateau formation in the centre, skirted by lofty ranges, whence great rivers run down to the sea, and many streams on the inland side forming great lakes; and along the seaboard are the same kind, though much less extensive, of lower plains with a tropical or sub-tropical climate. Here, as in Greater Asia, we have arctic snows and tropical heats, and the phenomena of Asia can be studied here more readily. Owing to the diversity of its relief, the climate is very varied, so that we can often pass from winter to summer in one day, as, for example, from the plateau of Karaman over the Pylæ Ciliciæ to the Aleian plain at Tarsus, where we find excessive heat.

It has claims on the *archæologist* by reason of its many buried cities; its ancient and mighty names that have vanished from sight, but must be discoverable somewhere; its scattered monuments, such as the unique rock monument of Doganlu, giving a

cue to the earlier origin of Greek peoples—the Pelasgians, the Phrygians, and the Gordians—how they have arisen from or blended with the Asiatics; its inscriptions in many dialects, of Greek, Saracenic, Arabic, Persian, Turkish, and Roman. Many famous sites, such as Antioch, Pisidia, Lystra, and Derbe, are not known; yet the plains and mountains abound with ruins so remarkable as to cause secrecy among the natives about them. Thus, seven or eight hours south of Kutaya there is said to be a great mine of ruins, which is probably Antioch; and on the side of the insulated mountain called Kara Dag, on the Konia plain, there are heaps called Bin-bir-Klissia (= 1,001 churches), which, no doubt, may prove to be Derbe.

It has claims on the *ethnologist* because, in a word, the problem of many races of opposite types fusing gradually into one is presented here; and the other problem, quite as difficult, why certain races, though living side by side for from six to ten centuries, refuse to fuse in any essentials. Here we have in chief the spectacle of three great races, differing in blood, language, and religion, seeking in vain to adjust themselves—the Greeks, Turks, and Armenians; and therefore more even than in Austria have we complicated problems in ethnology presented to us. Whereas the various Austrian States (German, Bohemian, Hungarian, Croatian, and Slavonic) have practically one religion, which forms some basis of union—the Christian divided between the Catholic and Greek churches,—here we have not only a divided Christian religion between the Greek and Armenian churches, but a divided Moslem religion between the sects of the Shiah and the Sunnis.

It is remarkable that Asia Minor, with such natural advantages, and so clearly limited by nature, has scarcely any history of its own. It has never been under one independent sovereign, but has been either divided among several minor potentates, or (as it is now under Turkish rule, and as it was under the Byzantine and Roman empires) merely a subordinate portion of a wider empire. Of its indigenous inhabitants we know nothing, except we presume that the Carians and Pamphylians, Paphlagonians, and the rest of the fifteen different nations described by Herodotus, were such. But from the same source and other sources we know that its western and northern shores were occupied from a very early period by Greek settlers from Europe. These Greeks, however, had hardly any influence upon the interior, about which, indeed, they knew little or nothing till Xenophon published his *Anabasis*. So

deep, indeed, was their ignorance, unrelieved by any tradition of former clanship with the people of the interior, that it affords presumptive proof, at least, that the Greeks, if they came originally from Asia, came into Europe by the north of the Black Sea and Thrace, and not through Asia Minor.

Our first definite information comes from Herodotus, who says that Asia—for that is the name by which the Greeks and Romans dignified the territory from the river Halys westward—had fifteen different races; but the names which they left to the provinces they dwelt in—Caria, Cilicia, and the rest—are the only traces (except a few traces of the Lycian language) they have left. Now, as the present population shows hardly a single trace of these earlier nations, the inference is that they were merged into the invading tribes of Turks, and went to change the Turk from the Mongol that he then was to the Mongolo-Caucasic that he now is. Indeed, these native races form by far the larger element of the population now known as Turks or Osmanlis. The true Osmanli may be said to have disappeared.

At present we find about a dozen different varieties of race in Asia Minor (*Anadoli* and *Karamani*), all differing more or less in descent, language, and social habits and religious creed. But since the minor varieties—Turcomans, Kurds, *Yürüks*, and *Kizilbashis*—may come under the head of Turkish, we may consider chiefly three—Turks, Armenians, and Greeks. Among these the Turks greatly preponderate, being two-thirds of the whole population; and they, too, compose the mass of the agricultural and rural population, while the Greeks and Armenians are almost exclusively in the towns. Thus, unlike *Rumeli* (Turkey in Europe), where the reverse is the case, *Anadoli* is the true home of the Turk. *But, be it observed, that according as a Turk is, or regards himself to be, of the true Ottoman stock, so will he be found averse to field life, and found dwelling in cities.* If he grudgingly admits kinship with the Anatolian husbandman permanently settled, he disdains to be thought the same race at all, or to be called by the same name, as the nomad or half-nomad Turcoman and other Tartar tribes, and gives *them* the sole use of the word “Toork,” as denoting in his mind a barbarian and a boor, which he, the proud, polished, urbane Osmanli, can never be. Nevertheless, “Toork” is the proper generic term to apply both to him and to them, and they go to prove the racial identity of the effendi of Stamboul with the far off Mongols and Tunghus

still grouped about the Ural-Altai in Central Asia : they are some of the innumerable transitions or steps in the great and otherwise almost incredible change.

As we find the Turkish races now in Anatolia, there are (1) the Turks proper or Osmanlis, the settled and fixed population—whose consideration I shall defer to the last ; and (2) the various minor tribes, more or less nomadic, who form about an eighth of the whole population. The latter, consisting of the Turcomans, the Yürüks, and the Kizilbashis, are exclusively pastoral, and *either* came in as the first instalments of the race before the conversion of the whole to Mohammedanism—as is most likely, judging from the many peculiar tenets and observances they still retain savouring of paganism,—*or* they came into their present haunts gradually after the great victory of Alp Arslan over Romanus Diogenes in 1071 A.D. While outwardly professing Mohammedanism, they hate the ruling race of Osmanlis, and are under their own chiefs in patriarchal government. We find the *Turcomans* all over Cilicia and Karamania, and even in the north-east, and by the ordinary traveller they can hardly be distinguished from the Yürüks ; but the difference is this—that, while the Turcomans have villages where they pass the winter months, and wander over the plains with their flocks and herds during the summer, the *Yürüks* live all the year round in tents, changing from place to place according to the season. I have passed their encampments as far west as Afiun-Kara-Hissar, and seen them on the plain south of the Taurus. Their tents of black and white goats' hair, and their long, lanky, swarthy persons, covered scantily with heavy cloaks of the same material, are familiar objects in the interior. Whether Turcomans or Yürüks, they do not intermarry with strangers, and so preserve the old harsh Mongol features at the same stage probably as they had when first they entered Asia Minor. They also speak a Turkish dialect, and therefore, both in speech and in appearance, they are still a living point of study in the history of the genesis of the Turks proper. As to the *Kizilbashis* (Red Heads), I think they are of the same descent, though probably of earlier settlement. They live in villages between Angora and Armenia, call themselves the Eski-Turk (Old Turks), and are like the others in physique—being large limbed, and dark and angular in features ; and like also in speech and in a freer manner of life than the Osmanli ; but they are decidedly more settled than the other tribes.

Two other races, which, although mainly Moslem, are yet not of Turkish race, remain to be mentioned—the Kurds and the Circassians. As to the *Kurds*, they are wandering tribes about the region of Kaisariyeh, and eastward toward Lake Van. They have a perfectly different language from the other nomadic tribes, being decidedly Aryan. In appearance they are also Aryan, or rather Caucasian, although they have some Mongolic characteristics strongly, such as their high cheek bones and dark fierce countenance, sparse beards or none. On the other hand, they are dolichocephalic, long-faced, with aquiline nose, and thick moustache. They approach in general nature to the Arab Bedouin, and in general habits do not seem to have changed much from their ancestors, the Carduchians, from whom Xenophon suffered so much in fighting his way northwards from Cunaxa.

As to the *Circassians*, they also are Caucasian. They are the most recent importation, and are to be found in many parts all over the peninsula—a source of terror to the settled peoples. They have been let in by the Turkish Government at various periods of this century to escape from Russian cruelty, and no doubt it was the Circassian blood within the Turk that spoke out this tender mercy, and that still prevents the Ottoman Government from suppressing this perfect nuisance to civilisation. I feel strongly on this point, because the Circassians were the only people that laid hands on my person in all Asia Minor. They prefer to go about in roving bands, armed to the teeth (yataghan, rifle, and shoulder-strap loaded with cartridges); but in some few places they have villages. When that is the case, they soon have the whole neighbourhood to themselves, for the unarmed Turkish peasantry hate and fear the Tsherkes, and flee from their presence. They carry their feudal structure of society with them, and obey their *voskh* (nobleman) even in defiance of the direct laws of the Ottoman Government. It was to obey one such that I had violence offered me. I had passed through their village, on the hills above the plain of Dorylaeum, without paying homage to him, and when that was discovered a hundred men, more or less armed, were sent after me up the hill, and in spite of my Imperial Ottoman *teskereh*, laid heavy hands upon me to induce me to return. The Tsherkes is a most serious disturbing element, to be reckoned with sooner or later at the cost of much bloodshed. Hopelessly indolent, plundering, levying blackmail right and left, and hectoring over the people and the rulers, I can compare him to nothing better than an

intrusion of dolerite lava among long-laid carboniferous strata, burning and blasting and contorting the peaceful accumulation of centuries. One thing I was much struck with is his likeness in build to the Russian, though he is much more regular in features. The Cossack and he are probably brothers.

I now consider the two races that differ from the Turk both in race and religion—the Greeks and the Armenians. As to the *Greeks* of Anatolia, there is not much mystery about their origin. They are the descendants of the ancient colonists all along the sea-board, where most of them still remain. They are found also in all the large cities, and although their villages are usually no more than two days' journey into the interior, occasionally we come across a Greek village farther in. In these latter cases, as indeed in the case of most individuals or communities found away from the coast, the mother tongue, Greek, has been given up and Turkish used. In the interior it was a daily occurrence for me to be introduced to a Greek, with the jocular remark added, "Yes, he's Greek, but knows no Greek!" Many a time I thought I had lit upon a prize when I found a man writing Greek characters, but found that the language, however, was Turkish. Strange to say, those whom I met able to speak Greek in the interior used almost always the Doric form of words, preferring the broad *ā* to the soft *ē* sounds. The so-called or self-termed Greeks in the interior are scarcely distinguishable, except by dress, from the Turks, while those on the coast are softer and slimmer, forming, in short, a sort of midway variety between the former and the European Greeks. I know two types of Greeks—one, small, thin, angular, keen-featured, vivacious, sarcastic, tricky, and rather of a brown complexion and hair, with greyish eyes: and the *other*, taller, broader, heavier, with flatter face, thicker features, and a formidable battery of white teeth, brownish eyes, heavy eyebrows, and black hair, wavy or curly; much slower in his movements than the other, indeed, with a certain languor in his air; more dogmatic also in his statements, but less disposed to argue; and altogether, I think, steadier in moral character. The latter, on the whole, is the best type of the Levantine—old Greek mixed with oriental blood and manners; while the former is the degenerate, wasted, but still truer lineal descendant of the old Attic and classic. How far either is from the old classic type of the master race, the type of Apollo (the perfection of the Caucasian ideal) is as great a wonder as the distance between the refined modern

Osmanli and the primitive Mongol. But while the Turks for six centuries have taken most of the good out of the Greeks and assimilated it to themselves, and imposed hard lines of tribute and servitude upon them, so as almost to destroy the Greek characteristics of patriotism and freedom, by fostering in them that more abject demeanour and cunning and deceit which they are now known by, and which they have but resorted to in self-defence; on the other hand, a great turn is taking place now, and the inherent Greek spirit, slumbering so long under ashes, is reasserting itself, and proving in all the arts and sciences of modern life that it may speedily again be true in a fuller sense than when it was first said, "*Graecia capta ferum victorem cepit.*" The Anatolian Greeks are to my mind a stronger race than those in Greece proper—above them in intelligence and practical sense; altogether superior in action, good at sea, good at the plough, good at letters, and in the professions; bent on rising and inheriting the earth; taking advantage of every help of school, college, books, and modern inventions; and everywhere proud of being descended from the ancient stock of heroes, writers, and artists that the modern world still deems the best. Not forgetting that Greece, as formerly, must be the centre of their nationality, they have nevertheless done their part for the Greek name and nation, and have recovered in Asia, not only their language, but the almost absolute control of, at least, the old Ionian western provinces. Smyrna is quite a Greek city, and it is the true capital of Anatolia.

As to the *Armenians*, I speak mainly of those outside of Armenia proper, and found scattered all over Asia Minor (and, indeed, over the world)—for these not only conserve the habits and religion of the mother country, but are the advanced representatives of whither the whole nation is tending in civilisation and power. I do not know of any nation so unfortunately placed—Russia, Persia, and Turkey are at their throats—nor of any so undeservedly "run down." Their peculiarly distinct Christianity marks them out at once from the Greeks and from the Moslems. The Turks and Kurds, their neighbours, detest them for their manifest superior craft; the Greeks sneer at them as being inferior in all respects. Notwithstanding, they are fast proving their superiority to both. Once they were brave and warlike and independent, and if they are peaceful and submissive now and crafty, it is because of their long political servitude.

They, now that western ideas have touched them, are showing all the qualities, as they have the incentives to rise in the scale. They have their ancient traditions and their distinct customs, and distinct church, and distinct language—and, I ask you, could they be either weaklings or cowards to have preserved such intact as they have? In business they are skilful and enterprising, having the whole of the trade of the east and north in their hands, and are the bankers and merchants and mechanics throughout the empire. Like the Greeks in being quick-witted and restless in energy, they are totally unlike them in their demeanour, which is grave, staid, reserved, and, however they may conform to necessity, always full of self-respect, and are really abler and more trustworthy, as they are also more earnest-minded, than the Greeks. They are steadily surpassing the Greeks, as they have already surpassed the Jews. In education and literature they are at the head. Speaking their own Armenian, they all know Turkish just as well, and all whom I have met know French pretty well. They are open to all western ideas and plans—yea, eager for them; and they translate into Turkish and Armenian the best works of Europe. Their convent on the Island of St. Lazarus in Venice (Mechitarist Monks) is the centre of Armenian literature, and is constantly adding to the stock. Altogether they seem to me the people to whom to intrust most safely the reform of Asia Minor; and the Turkish Government would seem to think the same, for they intrust Armenians with most of the commercial and sub-political affairs (such as tax-gathering, the governmental industries of tobacco, &c., railway and ship management).

They are altogether a strange study as a people. Like the Greeks in their business capacity, like the Turks in their taciturnity and reserve, they are also like the Jews in features and characteristics and pursuits, and also like them in this other particular that, though scattered over the world, they still cherish most fondly a secret hope of national restoration. It is absolutely untrue that they have no national spirit, and are completely given over to hoarding gold. I assure you they are strong patriots, and, moreover, anything but mean, but eagerly hospitable and liberal in their style of living. I have frequently lived with them, and, having got beneath their upper surface of "frost," found them most genial fellows. In demeanour they are frigid, puritanic, solemn; in features they are long-faced, with the nose and fore-

head too much of the same angle ; in fact, as a rule, Camper's facial angle is too large in them to be beautiful. They are striking in appearance, owing to having a fair complexion, often pallid, along with dark hair and eyes. Their women are often beautiful, and not kept so closely veiled or confined as the Turkish ; but they are made to serve at table, and usually don't speak to guests. In race they are said to belong to the Iranic branch of the Aryan family ; but the fact that recent research shows the Armenian (as well as the Afghan) language to be an independent branch of that same may lend more colour to the high pretensions to antiquity which the Armenians themselves make. One theory is that they are the Lost Ten Tribes of Israel ; and the native tradition is that they are that portion of Adam's immediate posterity, the sons of Haik (which is the name the Armenians call themselves), who did not after the Deluge leave their patrimonial estate near Mount Ararat, but remaining there near to the site of Eden, escaped the confusion of tongues at Babel, and, *ergo*, the language of the Armenians is the language of our first parents ! What can the poor pretences of our Gaelic friends do to that ?

And now we come to the *Turks*. The term "Toork" to the Byzantine authors and to the Arabs has a collective sense (like the old Scythians). We are wont to restrict it to the Osmanli Turks, who, however, decline it, saying that they ceased to be Turks by becoming imbued with Arabo-Persian culture ; but there are many tribes like the Ugurs (Ughurs) and Tatars, who still style themselves Toorks, and really are so. Now, according to the national Turkish traditions (preserved by historians like Rashed-ed-Din, who got them from Ugurian books now lost), the origin of the race is the same as the Mongols and other peoples still living around the Ural-Altai or Altun Dagh (mountain of gold)—peoples who occasionally come down and are met with by our sailors on the coast along the Indian Seas. The Ural-Altai stock language comprises five great branches—Mongolian, Tungus, Turki, Samoyede, and Finno-Ugrian, and these are in all essentials true to the mother tongue, and alike to one another. But it is not so with the racial branches, which have gone through so many divisions and sub-divisions that many are hard to reconcile with the parent, and even with the wider Mongol type. Chief among these hard thus to reconcile is the Osmanli Turk. But while we have undoubted evidence of this being his origin in

the indubitable affinity of the *language* he speaks and the present Mongolian language, we have to look backwards and eastwards, and compare the less mixed or less developed races, to find evidence that the Osmanli in *blood* also is fundamentally Mongolic.

*History* also helps us considerably. The Chinese record the doings of a people called Hiong-nu to the south of the Altaï, about 200 years B.C., and these have been identified with the Huns, which designation, loosely at least, includes the Mongol-Turks and the Finno-Ugrians — thus establishing the same remote ancestry for the Turk and for the Magyar of Hungary, who are held to belong to the latter class. One branch of the Hiong-nu, called by the Chinese Tu-kin (their name for Turk), was driven south-westward towards Asia Minor, settling in Turkestan (the place of the Turks), where they had by the thirteenth century undergone so great a change in outward appearance and habits, owing to the influence of the air and the water and frequent intermarriages, that, as Rashed-ed-Din relates, the change was so great as to strike their Iranian neighbours (Persians, &c.), who, therefore, called them Turkmans (not Turks, but Turk-like). And if a change was observable then, surely six centuries of contact with the higher civilisation of the west are sufficient to account for the almost total obliteration of the original Mongolic Ural-Altaic characteristics. That is one point in evidence. There are others, of which I cite three :—

(1) We look in vain in our modern Turk for the square face and pyramidal skull of the old pastoral Turks, but we find instead the oval and globular or sub-globular form of head belonging to the Caucasian Aryans, which modification we account for by the intermarriage with Circassian and Greek Aryans—a tribute of the fairest maidens which the Turks have for six centuries levied on the conquered, a habit which their ancestors had already learned in China long before, as the Chinese ruefully record. But, on the other hand, we find many transitional stages, such as the Ottomans must have passed through on their way to the west—for example, the Turcomans still unsettled in Asia Minor and elsewhere nearer the original home. Take the Kirghiz, for example, whom Ujfalvy regards as the best existing typical Turk—midway between the Mongol and the Caucasian. Burnaby describes them as half-wild wanderers over their bleak steppes; shepherds living in *kibitkas* (tents made of upright and transverse sticks); rather middle-sized, but muscular, dark, and shaggy;

their faces broad—the women with moon faces, little eyes, large mouths, bullet heads, and low foreheads. There you have the Mongol almost complete.

(2) Then, we too much forget the fact that there are Turks and Turks—ugly and rough Turks as well as fine and handsome; we forget that, while there are gentlemen born and bred, there are also boors; and that in many types of existing Turks in Asia Minor and elsewhere we find traces in feature and expression not unlike certain portraits of Huns we possess. For example, in the collection of terra-cotta figures found on a mound by the old wall of Tarsus in Cilicia, Mr. Barker, who found them, draws attention to an ugly head that is reasonably supposed to represent some chief of the Huns, who are known to have invaded Cilicia some centuries before Christ. Take away its hanging chin, draw the lips more together, and give a little more forehead, and you have, especially about the cheek, a type very familiar to me of the Turk found among certain classes (as moochtar or governor of little villages)—nay, one Bimbashi (Colonel) whom I stayed with, a very funny fellow, was of almost this very physiognomy.



HOODED HUN.

(3) Then we have a parallel case in the Magyars of Hungary. It is remarkable that the Magyars (the great body of whom came into Europe in the ninth century, and are of language and race akin to the Finns, and probably to the Turks) were described by the Europeans, when they first came from the Asiatic steppes, as perfectly hideous and Mongolic in appearance; yet, by the lapse of centuries of civilised settled life, they have so changed that they are now regarded, rightly in my eyes, as about the handsomest men and women in Europe; and mark also that the aristocrat (as familiar to us in the patriot Kossuth, and as delineated in young De Rohan of Whyte Melville's "Interpreter") is very distinct from the peasant in Hungary, showing more frequent intermarriage with the nobility of German blood, while the herdsmen on the moor, who have not had this advantage, are still coarse, wild, boorish, and comparatively ugly. So, exactly with the Turks, we can trace the shades of Mongol or Caucasian, according as the man is a pasha or a peasant.

The subjectivity of the Turkish ethnological class, as Latham would call it, must be very deep, that has withstood an almost obliteration of the primeval physical type, and yet has preserved the manners and character in life and speech. Indeed, physically, the Turk is more Caucasian than Mongolic—not only in appearance, but in reality, since we know how long and extensive has been his custom to pour the best blood of Caucasia and Georgia into his race through his harems. In stature he is taller than the average, and therefore than the ideal Mongol; he is fair rather than dark, smooth rather than angular of features. It is in the character of the Turk where we most readily see the Mongol—in his apathy and lethargic moods, and his almost madness when roused, and in his love of sensuous ease. The Magyar of Hungary is the truer Mongol of the two, as we see by the high cheek bones, the angular features, the dark complexion, the slighter build, the fitful vehemence, and the greater tendency to *embonpoint*.

Kinglake's Tatar (from Belgrade to Stamboul) is a good specimen of the Turk when found in his true element, that of active, stirring life, neither as an agriculturist nor as a dandy—"a glorious fellow, with that regular and handsome cast of countenance which is now characteristic of the Ottoman race. His features displayed a good deal of serene pride, self-respect, fortitude, a kind of ingenuous sensuality, and something of instinctive wisdom, without any sharpness of intellect." You see, even Kinglake could not portray the Turk without departing somewhat from conventional English, and neither can I. There is in all Turks—grown-up, at least—a peculiar reserve which is natural to them, displayed to each other as well as to strangers—a kind of introspection, as if the present task on hand were not the chief one, but another lay hidden, sacred, but yet to be revealed. There is also a certain unction which sometimes in the worse natures shows itself as an oily duplicity, sometimes in the better as a gracious suavity; and since we see this least in the boys and the young men, I am inclined to hold that it is superadded as an effect of their religion—no doubt added to ground already disposed to receive it by generations of heredity.

The Turk's religion is himself—part of him, always with him—never laid aside, and it has entered into his practical and actual life, not as a thing merely to regulate him, but as that which he lives; it is his life. Remove it (and what a wrench!), and you would require to remodel the whole man from infancy up.

More remarkable than in any set or sect I ever elsewhere saw is this phenomenon—more than in the priests of Christian churches, who are set apart to have no life but religion. Each ordinary Turk (layman) is deeper in religion than the Christian devotee. There is no such thing with them as hypocrisy; no such thing as religion “a thing apart from the life,” to be used or not, as is convenient: you take the soul out of the Turk if you divorce him from his faith and cult. And the result in his life is a sort of content. Absolute repose is there. And none who go among them from the West, longing for soul-rest, but are infected by that same spirit—the spirit of the East. The Holy Mother Church of Rome, and the fold of mental rest which it proffers, is not a patch on this; and if John Henry Newman had only been more deep in this Turkish quietism, I opine he never would have sought for a dubious repose beneath a cardinal’s hat. “Once a Moslem ever a Moslem,” as the rayahs put it, in disparagement, is the very best encomium on the sincerity and value of that cult.

I have made companions of two or three younger Turks, and the memory with me of them is a thousand leagues from that betokened by the name “unspeakable Turk.” Both were of good station; what tenderness and frankness were in them, and what trustfulness they showed in me! I will paint you one of them at Ilghun—the chief personage in the town. He lodged me in his own house, and invited all who might come to meet me. There they were—Greeks, Armenians, Circassians, and others,—noisy, jesting, drinking, while he, never sitting for a moment, stood smiling quietly and thoughtfully, good-naturedly pouring out the strong *raki*, and making cigarettes for them all the whole evening—he, the chief of the town, serving his subjects; then, after an orderly supper in the quiet of his own room, he wrapped me in rugs to keep out the severe cold, said his *namaz* prayer before retiring, and in gentle musical tones bade me “a pleasant sleep.” I still think of him in the words of the song, “Douglas, Douglas, tender and true!” Such a man makes it possible to conceive of the Saracen Saladin being what he is represented, to friend and foes alike, “generous, merciful, and honourable in the highest.” But had you seen my Douglas next morning you would have said, “What a different being!” To accompany me on my way, he bounded forth from the courtyard on a splendidly caparisoned stallion, through the crowded streets and over the rivulets—a glorious sight!—reposing majestically in the saddle, his true home,

and that of his ancestors ; and then as if to show his mettle, or pricked by a sudden impulse, he would dash away over the ground "as though for a moment he felt the mouth of a Turcoman steed, and saw his own Scythian plains lying boundless and open before him."

But you will say—"This is the picture of an ideal Turk, a gentleman : we want the picture of the common Turk." Well, he is not a very *common* character, but altogether notable. His true home is in Asia Minor, and how do find him there ? Very different, indeed, from the *effendi* of Stamboul or Europe, refined by Greek touch (whose very name *effendi*, corrupted from *αὐθέντης*, is significant of spurious culture)—the "gentleman" quite above exertion, who gets everything done for him, even the bringing up of his children. But the Turk is in Anatolia a rough, rude, gruff, blunt fellow, strong and emphatic in speech, stalwart and sinewy of figure, long-bodied, big-featured ; rejoicing always in a sense of physical superiority, even over his masters—for the Greek and Armenian merchants are usually the *big* men about a place ; very simple in tastes, habits, meals ; living a strange self-centred life (more than any other people I ever observed), wherein, content with little worldly means, but with a recognition that his race is the favoured race of heaven, he looks with scarcely any jealous eye on the growing riches and outward comforts of the Greek, Armenian, and Frankish settlers, who are working the mines of meerschaum at Eskisheher, or rearing and selling the opium of Afiun Kara Hissar, or making the wholesale profits of growers (while only or chiefly middlemen) from the goats of Angora or the fat-tailed sheep of Karamania. Their silent, staid manners in company, their amenability to government, their innate urbanity, their undercurrent of cheerfulness and humour, their manifest enjoyment of life as life, in the open air and in communion with nature : these are qualities in a people of the utmost value. Really, I often wish those Turks were Christians, that we might get at them more easily, for they are far and away the most noteworthy and self-contained, and most conscious of human dignity, of any people I know. And I should deem any man's life well spent in drawing them out to practical self-help, to the claiming of those aids to material stability and national permanence which Christian nations have and freely use ; but which the Turks, not disdainfully, but out of a sense of man's native moral superiority to all such material aids, put aside with

scarcely a second thought. In those men, I assure you, there is fire, latent energy, which on occasion can be educed, as we see when they are left to fight their own battles; and why, I ask, since it is scarcely ever used, there being no great cities to exact a drain on it, coupled with fine physique and fine morale, why should it not be educible for good and progress?

I affirm that the people are far better than their social condition and stage of civilisation—and should not a man always be above his manners? And, nevertheless, I seriously doubt if in any other country (such as Germany, the Austrian States, and the Balkan Principalities, with which I am familiar) you will find the peasant folks so orderly, so respectful, so well-regulated as to how to behave towards a stranger. Take, for example, how they give a reception in their khans, or, better still, in their *mussaphir-odassi* (guest-chamber), even in the humblest village; they always gave me the feeling as if I, a prince, were being presented to an assembly of princes. None of those filthy manners so disgusting among western peasants; none of that spitting and hawking, roaring, ranting, and rampaging; none of that bestial carousing and outrageous laughing, nor those threatening looks and words, and generally ill-disguised suspicion and contempt for the stranger who happens to be better dressed or finer-featured than they; but, instead, we find, with all their curiosity, which at the worst is but childlike, always a certain deference, along with a much stronger feeling of equal being with equal, which is very agreeable to a stranger.

“The love of money is the root of all evil”—not for the Turk, but rather “the want of that love.” He will not live for wealth—his wants are few, his fare frugal; civic and political life are not his concerns; he leaves such to the *Padishah* (Sultan) and his appointed representatives. Hence he has no ambitious career, nor anything to foster such; no universities are open to him, few or no schools; but when he is called by the conscription to be a soldier, he goes and serves his Sultan and his general without a murmur and without a question. Born lords of creation, warriors they came in, and as such they still hope, though vainly, to remain: let the conquered rayahs labour for them, and give the revenue up, they say. Now all that is changed in fact, but in form the Ottoman Government still fosters this system. The result is that, pressed on all sides, they would resist intrusion if they could, but cannot; just as we, committed

to the principle of Free Trade, would yet, if we could consistently, resist the invasion of foreign goods and workers, but prefer to suffer for our principle. And just as we allow our menial offices of cook, barber, waiter, milliner (and, until recently, music and painting), to be filled by Frenchmen and Germans and the like, so the Turks regard the Greeks and the other Giaours who are monopolising the trades and the arts in medicine, law, education, banking, and commerce:—

“ The eagle suffers little birds to sing,  
And is not careful what they mean thereby.”

Now, it is granted on all hands that trade and arts sharpen, but they also make too sharp (“smart” in the Yankee sense); and it is also granted that the pursuit of gain makes the character sordid, cunning, calculating, and that it is too often at the expense of natural dignity that a man carves out a money fortune—that the soul goes as the gold comes in. The Turk is in no danger of this, but the modern Greek is. The old Greeks knew perfectly well the truth of this when they put tradesmen and mechanics in the same social category as slaves—as ministers to necessities, which is their true function in life. Now the Turk, engaging little in trade, approaches the ideal of the old Greek citizen life; is big in soul, frank, generous, hospitable, honourable, and tolerant enough religiously. And I submit that such a character is preferable any day—whether from the old Christian standard of religious equanimity, or that of modern culture assimilating to the Aristotelian *αὐτάρκεια*—to that of the fussy, fretful, restless, roving, little Greek of modern type. But there is a reconciling compensation in both, as in all. For, just as the phlegmatic, splenetic, self-contained Englishman used to despise and underrate the “arts and cosmetics” of the Frenchman, so the reserved and contemplative, though somewhat indolent, Turk despises his rival, the Greek; and just as the Frenchman would shrug his shoulders at the Englishman—“He can’t cook, can’t dress, can’t paint”—and yet looks up to him because he can write poetry, and fight when need be, so the mercurial Greek wonders at the apathy and apparent incapacity of the Turk, and yet looks up to him because he can *live* poetry, and fight when need be.

GRAHAM LECTURE.

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VII.—*On the Basicity of Acids.* By A. CRUM BROWN, M.A., M.D.,  
D.Sc., F.R.S., F.R.S.E., F.C.S., F.I.C., Professor of Chemistry  
in the University of Edinburgh.

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[Fourth Triennial "Graham" Lecture, delivered before the Society,  
5th March, 1890.]

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I HAVE first to thank the Philosophical Society of Glasgow for asking me to undertake the duties of "Graham" lecturer. The position is an honourable and responsible one. Fitly to commemorate Graham and his work would task the powers of a man far more widely and intimately acquainted with chemistry and physics and with the history of experimental science than we can expect any one cultivator of science to be. And although you do not expect any one lecturer to bring more than a contribution to the monument, each lecturer must feel that he should contribute his best to the memory of one so eminently memorable as Thomas Graham—a man honoured by every man of science and loved by all who knew him.

The extraordinary simplicity of his character, the total absence of artifice or mannerism, his high-minded devotion to truth, his kindly humour, and his obvious ignorance that he was a great man, made intercourse with him easy and delightful. The description given of Maximus by Marcus Aurelius seems to me to apply more fully to Graham than to any man I ever met:—

"I observed that everybody believed that he thought as he spoke, and that in all things he never had a bad intention; and he never showed amazement and surprise, and was never in a hurry, and never put off doing a thing, nor was perplexed; nor did he laugh to hide his vexation; nor was he ever passionate or

suspicious. He was accustomed to do acts of beneficence, and was ready to forgive, and was free from all falsehood; he presented the appearance of a man who could not be diverted from right rather than of a man who had been improved. I observed, too, that no man could ever think that he was despised by Maximus, or ever venture to think himself a better man. He had also the art of being humorous in an agreeable way."

After some difficulty I have chosen as the special subject of this lecture the Basicity of Acids—an idea which originated with Graham,—and purpose to trace the development of that idea, and to discuss the criteria which have been proposed for the determination of the basicity of an acid.

When Graham began his investigation on the phosphates and arseniates (1833), the phosphates of soda known were the common phosphate and the so-called biphosphate, and these were written (using for convenience the present atomic weights, but otherwise retaining the formulæ of the time),  $2\text{Na}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ ,  $25\text{H}_2\text{O}$ , and  $\text{Na}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ ,  $4\text{H}_2\text{O}$ . Clark had shown that when the common phosphate of soda is heated it loses all its water, and is converted into a new salt, to which he gave the name of pyrophosphate. Graham here gives, as he always does, full credit to all who went before him, and cites their work with full particulars. We need not follow him in this now, for the conclusions he drew were altogether his own. He describes the preparation of a new salt—a phosphate of soda corresponding to the "subsesqui-phosphates"—by the action of common phosphate of soda on caustic soda. This salt had the composition  $3\text{Na}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ . The old nomenclature sounds to us strange, and is indeed somewhat inconsequent. Phosphates of the type of common phosphate of soda,  $2\text{Na}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ , with an oxygen ratio of 2 : 5, were called "phosphates," or "neutral phosphates;" biphosphates had twice as much acid for the same quantity of base, and an oxygen ratio of 1 : 5; and those phosphates which contained  $1\frac{1}{2}$  times as much base for the same quantity of acid as the neutral phosphates, with, therefore, an oxygen ratio of 3 : 5, were called subsesqui-phosphates. The name of sesquiphosphate would naturally have been given to a salt containing  $1\frac{1}{2}$  times as much acid for the same quantity of base as the neutral salt. The so-called subsesqui-phosphate contains for the same quantity of base  $\frac{2}{3}$  of the acid present in the neutral salts; but we need scarcely discuss in a pedantic way a nomenclature now quite obsolete and forgotten.

Graham showed (1) that this new salt gives, with nitrate of silver, a precipitate of the ordinary yellow "subsesquiphosphate" of silver, and that the solution from which the precipitate has settled is neutral; and (2) that the new salt in the crystalline form is permanent in the air, but that its solution is attacked by carbonic acid, with the formation of carbonate of soda and common phosphate of soda.

He examined the action of heat on common phosphate of soda,  $2\text{Na}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ ,  $25\text{H}_2\text{O}$ , and showed that  $\frac{24}{25}$  of the water can be expelled at the temperature of boiling water, but that the last  $\frac{1}{25}$  requires a much higher temperature for its removal; and he also showed that as long as this  $\text{H}_2\text{O}$  remains, the salt when dissolved in water has all the properties of common phosphate, and that it is its removal that converts the salt into pyrophosphate.

He next examined the reaction of the pyrophosphate, confirming Clark's observations, and showing that the white silver salt has the oxygen ratio, 2:5, the same as that of the soda salt, and that therefore the solution remains neutral.

Subsequently he examined the action of heat on the "biphosphate of soda,"  $\text{Na}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ ,  $4\text{H}_2\text{O}$ ; he showed also that the corresponding potash salt is  $\text{K}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ ,  $2\text{H}_2\text{O}$ . This potash biphosphate remains unchanged when heated to  $400^\circ\text{F}$ ., its crystalline faces losing nothing of their lustre. The soda salt loses half of its water at  $212^\circ\text{F}$ ., and then corresponds in composition to the potash salt. At about  $370^\circ\text{F}$ . it again begins to lose water, and when kept for some time at  $400^\circ\text{F}$ . loses half of the remaining water, becoming  $\text{Na}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ ,  $\text{H}_2\text{O}$ . When now dissolved in water it has still an acid reaction, but gives all the reactions of an acid *pyrophosphate*. It can be heated to  $450^\circ\text{F}$ . without losing any more water. When heated to a temperature just short of dull redness it loses practically all its water and is converted into another new phosphate of soda,  $\text{Na}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ . The salt so prepared is only in part soluble in water; the soluble and the insoluble part have the same composition. On being strongly heated it becomes entirely changed into the insoluble salt; and when this insoluble salt is heated to dull redness it fuses, and the fused mass, when cooled, dissolves easily in water. This new salt Graham called metaphosphate of soda; it is now often called "Graham's salt." From it he obtained the corresponding baryta, lime, lead, and silver salts. These he describes fully, and shows how from the lead salt, by the action of sulphuretted hydrogen, the acid can be obtained—an acid differing altogether

from common phosphoric acid; it is metaphosphoric acid, and resembles the acid obtained by dissolving glacial phosphoric acid in water.

So far the results of Graham's experiments are described by him with full analytical detail, using the then current language. At the end he proceeds to sum up the matter. He shows that there are three essentially different phosphoric acids, and that the difference is to be seen in the different oxygen ratios of their salts. For this purpose, the water—not water of crystallisation, but that water which is retained when the salts are heated to temperatures above  $212^{\circ}$  F.—is regarded by him as part of the base, and phosphate of soda— $2\text{Na}_2\text{O}, \text{H}_2\text{O}, \text{P}_2\text{O}_5$ —is seen to be strictly analogous to phosphate of silver,  $3\text{Ag}_2\text{O}, \text{P}_2\text{O}_5$ , and to his new "subsesqui-phosphate of soda,"  $3\text{Na}_2\text{O}, \text{P}_2\text{O}_5$ . The oxygen ratio in all these salts, as also in common phosphoric acid,  $3\text{H}_2\text{O}, \text{P}_2\text{O}_5$ , is 3 : 5.

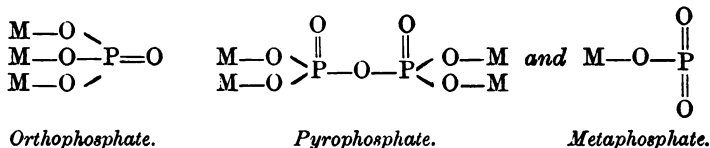
There is now no marvellous anomaly in the fact that solution of phosphate of soda, neutral, or rather somewhat alkaline, when mixed with solution of nitrate of silver, neutral, should give an acid solution. The bases change place; and  $2\text{Na}_2\text{O}$  and  $\text{H}_2\text{O}$ , the bases in the phosphate, change place with  $3\text{Ag}_2\text{O}$  of the nitrate, giving  $2(\text{Na}_2\text{O}, \text{N}_2\text{O}_5)$  and  $\text{H}_2\text{O}, \text{N}_2\text{O}_5$ .

We have again a second set of phosphates, with a different  $\text{P}_2\text{O}_5$ , the character of which is that it forms salts with an oxygen ratio 2 : 5—the pyrophosphates; and a third set with a third kind of  $\text{P}_2\text{O}_5$ , in which the oxygen ratio is 1 : 5—the metaphosphates. Graham fully recognised that there were varieties of metaphosphates. He confined his special examination to that set of metaphosphates with which his name is associated; it was left for Fleitmann and Henneberg to work up—as they did, with great care and fulness—the special characters of these varieties.

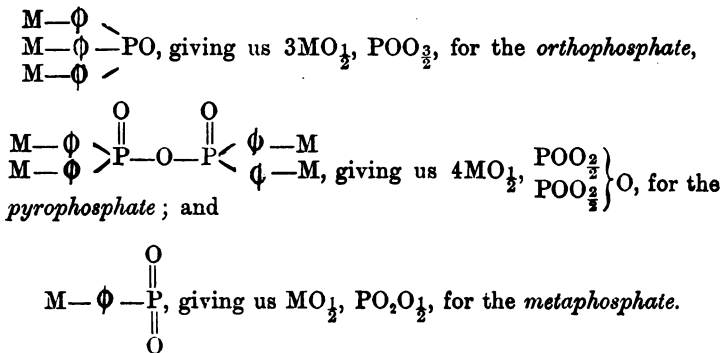
I have given a short sketch of Graham's investigations. The most of the facts discovered by him are well known to every student of chemistry—examination papers are full of ortho-, pyro-, and meta-phosphates—but how few read the original account of the discovery, or really understand how the discovery was made.

Graham attributes the difference between the common phosphates, the pyrophosphates, and the metaphosphates to the existence in each set of salts of a special kind of phosphoric acid,  $\text{P}_2\text{O}_5$ . Let us see how far our newest views—not necessarily the last word that Science has to say on the subject—justify this

notion. We now write orthophosphates, pyrophosphates, and metaphosphates thus :—



Now the dualistic formula of an oxygen salt can always be got from its graphic formula by drawing a line through each of the O's, which are jointly united to the metal and to the radical of the acid. In the cases before us we have therefore :—



I can easily suppose that these dualistic formulæ will be laughed at as involving the absurd notion of fractions of atoms, but we must recollect that the dualistic formulæ were not molecular formulæ. The dualistic formulæ as used by Berzelius and Graham can be got from those just now given by multiplying, so as to get rid of fractions. When we do this we get  $\text{P}_2\text{O}_5$  as the formula of the anhydride in all three cases ; but when we apply our present knowledge to the explanation of what is true in the dualistic way of representing the constitution of oxygen salts, we see that we ought to retain the fractions. Let us take a simple case. Caustic potash is for us  $\text{K}-\text{O}-\text{H}$ . To make a dualistic formula of this we draw a line through the O which is jointly united to the K and to the H, thus— $\text{K}-\phi-\text{H}$ , and write  $\text{KO}_{\frac{1}{2}}, \text{HO}_{\frac{1}{2}}$ . The substance is indeed a compound of oxide of potassium, in which the potassium is in the same state of oxidation in which it is in  $\text{K}_2\text{O}$  ( $\text{KO}_{\frac{1}{2}}\text{KO}_{\frac{1}{2}}$ ), and of oxide of hydrogen, in which the hydrogen is in the same state of oxidation in which it is in water ( $\text{HO}_{\frac{1}{2}}\text{HO}_{\frac{1}{2}}$ ). We now know, or at least see

something of the reason why these two things are united together; the  $O\frac{1}{2}$  in the one and the  $O\frac{1}{2}$  in the other are the two halves of a single indivisible oxygen atom, and therefore a dualistic formula *must*, if it is to conform with modern notions, contain the same number of half oxygen atoms in its basic part and in its acid part.

It is very interesting to observe that, a month or two before Graham's work on the phosphates and arseniates was published, Berzelius and Liebig interchanged views on the constitution of the citrates, a class of salts afterwards recognised by Liebig to be quite analogous to the orthophosphates. Citric acid, as we now know, has the formula  $CH_2(COOH) \cdot C(OH)(COOH) \cdot CH_2(COOH)$ , that is to say,  $C_6H_8O_7$ . Writing this dualistically, on the principle just explained, we have for a normal citrate, say sodium citrate —  $3NaO\frac{1}{2}$ ,  $C_6H_5O_4O\frac{3}{2}$ . Errors of analysis led chemists to suppose that the anhydrous acid in these salts contained equal numbers of atoms of the three elements, carbon, hydrogen, and oxygen: the only question was how many of each? The common idea, that of Berzelius, was that anhydrous citric acid was  $C_4H_4O_4$ . (If the true composition of citric acid and the citrates, as made out five years later by Liebig, had been known, the simplest dualistic formula possible for sodium citrate would have been seen to be  $3Na_2O$ ,  $C_{12}H_{10}O_{11}$ .) Berzelius in his first letter points out the anomalies of the citrates, and shows why the analyses of lead citrate lead to no satisfactory result, because precipitated lead citrate constantly loses acid when washed with water, leaving a more and more basic salt. He, therefore, crystallised lead citrate from solution in very weak nitric acid, and so obtained what he considered a definite acid citrate of lead.

Liebig in his reply points out that while anhydrous citric acid contains equal numbers of carbon, hydrogen, and oxygen atoms, it may be represented as  $C_3H_3O_3$ ,  $C_4H_4O_4$ , or  $C_6H_6O_6$ , and gives a table of all the analysed citrates, with a formula for each, on each of these three hypotheses. Berzelius replies to him, and the only things we have here to notice in his letter are:—

1st. That he states that, taking the formula  $(C_6H_6O_6)$ , preferred by Liebig, we should have the great anomaly that the perfectly neutral citrate of soda would have the formula— $2\text{ Ci} + 3\text{ Na}_2\text{O}$ , that is to say, that a salt of a strong alkaline base, with excess of base, is neutral. By excess of base he means more than one  $Na_2O$  for one unit of the anhydrous acid.

2nd. That he says, "I think it is, therefore, better to wait for

the result of further experience in the field of organic chemistry ; it is very possible that the explanation may come of itself and unsought."

Let us pause for a moment and look at the state of matters in 1833. Graham had distinctly formulated the principle that there were three different classes of acids (anhydrides)—

1st. Those, one unit of which was saturated by one unit of a basic oxide containing one O. *Examples*—Metaphosphoric acid and the great majority of known acids.

2nd. Those, one unit of which requires for saturation two units of such basic oxides. *Example*—Pyrophosphoric acid.

3rd. Those, one unit of which requires for saturation three units of such basic oxides. *Example*—Common phosphoric acid.

In classes 2 and 3 the units of basic oxide saturating the acid might be all the same or different, and that oxide of hydrogen, water, might be one of them. Further, we see that at the same time, or a few months earlier, the two greatest chemists of the time considered it a strange and anomalous thing that a neutral salt should consist of anything but one unit of acid and one unit of basic oxide containing one O.

We have thus contemporaneous written proof that Graham's idea was altogether new : quite unknown and strange to the most eminent chemists. This idea of Graham's was what we now call Basicity, and he expressed it in a perfectly full and general way. We shall see that it was capable of great development, and that it could be translated into any kind of chemical language without losing its original meaning. We shall see also that, like all great general ideas, it was capable of being misused.

We must now go back to 1815, in which year Davy published his views as to the constitution of acids. Davy had shown that chlorine must be regarded as an element, and that, therefore, hydrochloric acid contains no oxygen. This discovery led to the division of acids and salts into two sets—that containing hydrochloric acid, the chlorides, and their analogues, and that containing oxygen acids and salts, such as sulphuric and nitric acids, the sulphates and the nitrates. Davy, looking to the fact that hydrochloric acid and hydrated chloric acid, potassium chloride, and chlorate of potash differ only in that chloric acid and the chlorate contain oxygen in addition, and that potassium chloride and chlorate of potash are equally neutral, and that the same relation is seen in the case of iodides and iodates, suggested

that the hydrogen in the acids and the metal in the salts were similarly related to the rest of the compound in all these bodies, and that, in fact, there was no essential difference in their constitution. This view was stated with greater generality and precision by Dulong, who regarded all hydrated acids as compounds of hydrogen and something else—this “something else” being all the rest of the compound. Thus, nitric acid is  $\text{H NO}_3$ , sulphuric acid  $\text{H}_2 \text{SO}_4$ , nitrate of potash,  $\text{K NO}_3$ , sulphate of potash,  $\text{K}_2 \text{SO}_4$ , oxalic acid,  $\text{H}_2 \text{C}_2\text{O}_4$ , &c. This view, which we may call the Davy-Dulong theory, was vehemently opposed by most chemists. Was it conceivable, it was asked, that  $\text{SO}_3$ , a substance that easily enough gives up one-third of its oxygen, should take oxygen away from hydrogen or potassium to form an unknown higher oxide of sulphur, and how could hydrogen or potassium unite with this higher oxide of sulphur, without taking oxygen away from it? The case seemed even more absurd with nitric acid. As we now look on the constitution of these substances, we see that such questions imply an exchange not really involved in the Davy-Dulong theory. We see that the H and the K in the acids and in the salts are not separated from oxygen, although they are united to  $\text{SO}_4$  or  $\text{NO}_3$ , and that the Davy-Dulong theory is not inconsistent with the dualistic mode of representation. At the time, however (1815-16), when this theory was brought forward, the way by which it could be reconciled with dualistic notions was inconceivable, and for long this grouping of hydrogen acids and oxygen acids together was looked on as an ingenious speculation worth referring to, but not fit to be used in ordinary practice.

In 1838 Liebig published a memorable paper on the Constitution of Organic Acids. He analysed the following acids and their salts:—meconic acid, citric acid, pyrocitric acid, cyanuric acid, aspartic acid, gallic acid, tannic acid, tartaric acid, racemic acid, and malic acid. In reviewing the results, along with the results of former analyses of meconic acid, pyromeconic acid, tartrilic acid, tartrellic acid, pyrotartaric acid, mucic acid, and fumaric acid, he points out the similarity of certain phenomena observed in the case of the salts of many organic acids to those pointed out by Graham in the case of the phosphates. He divides the acids into three groups, to which he gives the names now universally used,—namely, monobasic, dibasic, and tribasic (*einbasisch*, *zweibasisch*, *dreibasisch*), corresponding to Graham's three phosphoric acids.

The most interesting points in this paper are as follow :—

1st. The complete recognition of the accuracy of Graham's practical and theoretical work, and the application of Graham's ideas to the case of organic acids.

2nd. The laying down of a criterion for the determination of the basicity of an acid. This criterion is the formation of definite salts with more than one base: to give an example, tartaric acid is dibasic, although its formula can be halved so as to make it appear monobasic, because it forms Rochelle salt, a perfectly definite salt, with two different but closely analogous bases. Liebig's argument here is not quite consequent, because he did not recognise sulphuric acid and carbonic acid as dibasic, and therefore was put to some trouble to explain the double and acid salts of these acids. We shall see how much discussion had to be gone through before this point was finally settled.

3rd. His indication that, as a rule, monobasic organic acids do not form "pyrogenic acids." This is a very interesting part of the paper. It was impossible in the then state of chemical theory to put it in a clear form, but the reference to it is a proof of Liebig's grasp of chemical theory. In the dim light of that time he saw what we now see clearly, and in reading his paper we must keep in mind what was known then; but I mention it now as evidence of Liebig's extraordinary power of hitting upon the vital points in chemical questions.

4th. The complete acceptance by Liebig of Davy's theory—the theory which I have called the Davy-Dulong theory. Liebig points out that other compounds besides hydrochloric acid and hydrated chloric acid, or the corresponding iodine compounds, might be used to support Davy's views—he instances  $\text{H}_2\text{S}$ ,  $\text{H}_2\text{SO}_3$ ,  $\text{H}_2\text{SO}_4$ ,  $\text{H}_3\text{P}$ ,  $\text{H}_3\text{PO}_3$ ,  $\text{H}_3\text{PO}_4$  as similar cases.

5th. His representation of pyro- and meta-phosphoric acids as compounds of orthophosphoric acid with anhydrous phosphoric acid, so that we may look upon these as partial anhydrides—orthophosphoric acid being the real phosphoric acid. It is, indeed, a little difficult for us to follow him in this discussion, but a careful reader will be able to find his way. The analogy which he draws between the formation of pyrogenic acids and the formation of pyro- and meta-phosphoric acids from common phosphoric acid is most suggestive.

It would be wrong to say that the idea of basicity originated in this paper. That idea was unquestionably contained in Graham's

paper on the phosphates and arseniates, and Graham's right as the author of the idea is fully recognised by Liebig, but it is certain that this paper of Liebig made this idea popular. He brought forward so many new cases, and put the whole matter in a general form before the chemical world that no one could avoid dealing with it. As long as the phosphates and arseniates—the only salts showing these peculiarities examined by Graham—were the only examples of polybasic acids, it was possible for chemists to look upon them as stray, exceptional cases; but when Liebig showed that there were many organic acids of quite the same kind, this could no longer be done. Liebig's work had thus the effect of practically introducing the idea of basicity to chemists, because it was no longer possible to make any progress in organic chemistry without constantly making use of it. There is an argument in favour of Davy's theory in the paper that I have been discussing which is worthy of particular notice, because, although highly plausible and no doubt really effective at the time, we now know that it is quite erroneous. Liebig points out that there are two possible views of the constitution of sulphocyanic acid,  $\text{H}_2\text{S}$ ,  $\text{Cy}_2\text{S}$ , and  $\text{H}_2$ ,  $\text{Cy}_2\text{S}_2$ . The former corresponds to the usual dualistic theory of hydrated sulphuric acid,  $\text{H}_2\text{O}$ ,  $\text{SO}_3$ , the latter to Davy's theory,  $\text{H}_2$ ,  $\text{SO}_4$ . Now, if the former is correct, lead sulphocyanide is a compound of lead sulphide,  $\text{PbS}$ , and  $\text{Cy}_2\text{S}$ . How then could it be decomposed by  $\text{H}_2\text{S}$  giving  $\text{PbS}$  and sulphocyanic acid, the lead being already there as  $\text{PbS}$ ? But cyanic acid has the same constitution as sulphocyanic acid with oxygen instead of sulphur, so that if  $\text{H}_2\text{S}$ ,  $\text{Cy}_2\text{S}$  will not do for the one, neither will  $\text{H}_2\text{O}$ ,  $\text{Cy}_2\text{O}$  do for the other. Now, though it seems reasonable enough at first sight to argue that  $\text{H}_2\text{S}$  cannot decompose  $\text{PbS}$ ,  $\text{Cy}_2\text{S}$  because the lead is already there as  $\text{PbS}$ , Liebig seems to have forgotten that quite as good an argument could have been got without going so far a-field as sulphocyanides for it. Chemists were quite familiar with cases in which one oxide seems to turn out another oxide from a salt. This idea suggested nothing absurd to their mind; it was, in fact, the usual way of representing a large class of chemical changes. But if Liebig was right it was as absurd to think of potash turning out oxide of copper, the copper being already in the salt there as oxide of copper, as to think of sulphide of hydrogen turning out sulphide of lead. The reference to the sulphocyanides adds, in fact, nothing to his argument; but because the precipitation of  $\text{PbS}$  from lead salts in which the lead

was not united to sulphur was familiar, and the precipitation of PbS from soluble lead salts in which the lead was already united to sulphur was unfamiliar, there seemed something unnatural and absurd in the latter, whereas the precipitation of oxide of copper from oxygen salts of copper presented no such apparent absurdity. Further, we now know that sulphocyanic acid is not the real analogue of cyanic acid, that  $\text{H}_2\text{S}$ ,  $\text{Cy}_2\text{S}$ , or rather  $\text{HS}\frac{1}{2}$ ,  $\text{CyS}\frac{1}{2}$ , is a correct dualistic formula of sulphocyanic acid, and that  $\text{H}_2\text{O}$ ,  $\text{Cy}_2\text{O}$  (or  $\text{HO}\frac{1}{2}$ ,  $\text{CyO}\frac{1}{2}$ ), is not a correct formula of cyanic acid. The whole argument therefore falls to the ground, but it once stood as an effective argument, and no doubt did good service in persuading chemists of the reasonableness of Davy's theory. We all accept Davy's theory now, but not quite in his sense of it. There is no doubt that the adherents of the old radical theory, including Davy and Liebig, looked upon compound radicals as something more than "residues of double decomposition." When they referred to  $\text{H}_2\text{SO}_4$  they meant to imply that the hydrogen was united to the  $\text{SO}_4$  as a whole, as an estate belongs to a corporation. When the notation  $(\text{HO})_2\text{SO}_2$  was suggested it never occurred to any one that this could be reconcilable with the Davy-Dulong formula. We now see this, and write  $\text{H}-\text{O} > \text{S} \begin{smallmatrix} \text{O} \\ \parallel \\ \text{O} \end{smallmatrix}$ , and see that it all depends on where we draw a line across the formula whether it means  $\text{H}_2\text{SO}_4$  or  $(\text{HO})_2\text{SO}_2$ , and that in some reactions the compound breaks in the one way, and in some in the other.

Another point worth noticing in the classification of acids by Liebig is that, while he gives a criterion of basicity, he does not apply it to sulphuric, sulphurous, or oxalic acid, all of which he considers monobasic. Laurent has pointed out this inconsistency in his "Chemical Method," in which he proposes, as we shall see, new criteria of basicity.

The next great step in the development of the theory of basicity turns on the question of the atomic weights of the electro-negative elements. This leads us to the long controversy—one of the most important chemical controversies of our time—that in which Gerhardt, Laurent, and Williamson represented the new views against, at first, the great majority of chemists. We may call this controversy a war as to the atomic weight of oxygen. It is true that the new views involved far more than this; but when this point was gained, all the rest was at once yielded, and the

whole question of the replacing value of the electro-negative elements was settled. In scientific controversy, as in war or in political contests, although the actual question in dispute may be very complicated, there is usually one point round which the battle rages: that point gained, the opposition collapses.

Dalton, to whom we necessarily go back when we trace the history of atomic weights, chose hydrogen as his unit atom, and, choosing simple formulæ for the commonest compounds, selected as the atomic weights of oxygen, carbon, and nitrogen, the numbers 6·5, 5, and 5, respectively. This gave (using alphabetical symbols instead of Dalton's circles) HO for water, NO for nitrous gas (nitric oxide), N<sub>2</sub>O for nitrous oxide, NH for ammonia, &c. The numbers are, of course, not accurate; that is to say, they are not what Dalton would have made them if he had had access to really good analyses; but it is the matter of principle I wish to treat of here, and not the numerical details of analyses. Correcting the numbers given above we get H=1, O=8, C=6, N=4 $\frac{2}{3}$ ; using which and Dalton's formula we arrive at accurate statements of the composition of the substances above named. After trials of various systems proposed by Wollaston, Thomson, and others, that was generally adopted in this country which may be characterised by the examples—H=1, O=8, N=14, S=16, Na=23, Fe=28.

The ratio O:H was considered by Berzelius as determined, on the principle of Gay-Lussac, by the relative density of the gases, and therefore, arbitrarily taking O=100, he put H=6·25. But this ratio, 16:1, is that of the atoms, not of the equivalents. The ratio of the equivalents of oxygen and hydrogen is the ratio of the elements in water, namely, 8:1; and therefore, if we put O=100, and make this the standard both of atomic weight and of equivalence, the atomic weight of hydrogen is 6·25, and its equivalent 12·5.

But Berzelius could not admit that the unit of any compound should be represented as containing a fraction of an equivalent, and therefore all his formulæ in which hydrogen occurs contain a whole number of equivalents, that is to say, an even number of atoms of hydrogen—thus we have H<sub>2</sub>Cl<sub>2</sub>, N<sub>2</sub>H<sub>4</sub>, &c.

So that for practical purposes no advantage was gained by using atomic weights rather than equivalents, and by-and-by the device was fallen upon of drawing a bar through the atomic symbol of those elements which, like hydrogen, always occur in Berzelian

formulæ in pairs, thus— $\text{HO}$ ,  $\text{HCl}$ ,  $\text{NH}_3$ , instead of  $\text{H}_2\text{O}$ ,  $\text{H}_2\text{Cl}_2$ ,  $\text{N}_2\text{H}_6$ .

This practice became so generally adopted on the continent that before long there was practically no one left who used the unbarred H, Cl, N, and then the convenience of the printer led to the use of plain H, Cl, N in place of  $\text{H}$ ,  $\text{Cl}$ ,  $\text{N}$ —a change perhaps first adopted by Gmelin, whose example contributed greatly to its extension. Thus the system came to be the same as that used in this country, and there was for a time a universal chemical notation.

I shall not occupy your time with a detailed account of the discussion as to the atomic weight of oxygen; I shall merely indicate the general line of argument. The view of Avogadro (1811), and Ampère (1814), that under the same external conditions the number of true molecules in a given volume is the same for all gases, and that, therefore, the molecular weights of two gases are to one another as the densities of the two gases at the same temperature and pressure, had not received much attention from chemists and physicists, and had been practically forgotten. Gerhardt and Laurent made it the foundation of their system, and by carrying it out consistently found that (with certain exceptions now fully explained) the volatile compounds of oxygen could all be represented by means of formulæ in which O had the value of 16 ( $\text{H} = 1$ ), and that, of course, if O is given half this value all these formulæ contain an even number of atoms of oxygen. The same argument applies to sulphur and carbon, and the result was that Laurent and Gerhardt adopted, in the case of all the non-metallic elements, the atomic weights of Berzelius. As to the metals, Berzelius, not having the vapour density to guide him, and therefore unable to distinguish, as he supposed he could in the case of hydrogen, between the equivalent and the atom, adopted the equivalent as the atom—the equivalent of a metal being the quantity of it which combines with an atom of oxygen, corresponding therefore to the equivalent of hydrogen ( $\text{H}_2$ ). Where a metal forms more than one oxide he selected one of these as the simplest, giving it the formula  $\text{MO}$ , and from the equivalent thus obtained, and assumed to be the atom, constructed formulæ for the other oxides. To alumina, the only oxide of aluminium, he gave the formula  $\text{Al}_2\text{O}_3$ , from the analogy of  $\text{Fe}_2\text{O}_3$ .

Gerhardt was as much in the dark as Berzelius as to the  
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vapour densities of metals and their compounds, and proceeded as he did, adopting the equivalent instead of the atom. But with Gerhardt the equivalent was the quantity of the metal interchangeable with one atom of hydrogen, so that, as a rule, Gerhardt's equivalents of metals are one-half of Berzelius' atoms. Gerhardt carried out his principles more consistently than Berzelius. He did not assume that the equivalent is the atom, and so was able to use different equivalents for the same metal in different series of compounds. All basic oxides have thus with Gerhardt and Laurent the formula  $M_2O$  (like  $H_2O$ , with which they are in the strictest sense equivalent), in which O stands for an *atom* of oxygen, and M for an *equivalent* of the metal.

The use of these new formulæ show clearly that sulphuric, sulphurous, and oxalic acids must be dibasic, and Gerhardt and Laurent gave proof from the composition of their salts that they are so. Williamson at once allied himself with Gerhardt and Laurent, and gave, as his first contribution to the discussion, two papers on Etherification. The constitution of alcohol and ether had been the subject of much discussion, and two views were held at the time we are now speaking of. According to both of them alcohol was regarded as a compound of ether and water, ether being represented as  $C_4H_{10}$ , HO, or  $C_4H_9O$ , and alcohol as  $C_4H_9$ , 2HO or  $C_4H_8O$ , HO. In Laurent and Gerhardt's system they became, respectively,  $C_4H_{10}O$  and  $C_2H_6O$ . It was therefore important to show that ether contains something more and not something less than alcohol. Williamson obtained ether by the action of iodide of ethyl,  $C_2H_5I$ , on potassium alcohol,  $C_2H_5KO$ , indicating that ether is  $C_2H_5C_2H_5O$ , and brought further proof by the discovery of the mixed ethers  $RR'O$  by the action of  $RI$  on  $R'KO$ , where R and R' are two different alcohol radicals. He points out the relations of alcohol to acetic acid, shows that alcohol may be regarded as a weak acid ( $\frac{C_2H_5O}{H}$ , forming salts  $\frac{C_2H_5O}{K}$ ,  $\frac{C_2H_5O}{C_2H_5}$ ,  $\frac{C_2H_5O}{CH_3}$ ), and, comparing the increase of acid character in passing from alcohol,  $\frac{C_2H_5O}{H}$ , to acetic acid,  $\frac{C_2H_3O}{H}$ , to the similar increase in passing from phenylic alcohol (phenol), through various stages to carbazotic acid (picric acid); quite incidentally he mentions his discovery of the mixed ketones. But important as these papers are on account of the discoveries contained in them, one of which, that of the mixed ethers, directly led to Gerhardt's great discovery of the anhydrides

of the monobasic organic acids; of still greater importance and influence on the development of the science are the theoretical remarks contained in them and in a paper on the constitution of salts published immediately after. They contain the germs of two great theories—the theory of valency and the modern theory of electrolysis, both of which bear directly on our subject of basicity. He describes the relation of potassium carbonate to caustic potash thus—"one atom of carbonic acid is here equivalent to two atoms of hydrogen, and by replacing them holds together the two atoms of hydrate in which they were contained, thus necessarily forming a bibasic compound,  $(\text{CO})\text{O}_2$ ,  $\text{K}_2$  carbonate of potash." Similarly, he represents oxalic ether as  $2\text{C}_2\text{H}_3\text{O}_2$ , in which the  $(\text{CO})_2$  takes the place of two atoms of hydrogen in alcohol,  $2(\text{C}_2\text{H}_5\text{O})$ .  $\text{SO}_2$  is given as another radical capable of replacing hydrogen, giving  $\text{SO}_2\text{O}_2$ ,  $\text{SO}_2\text{O}_2$ ,  $\text{SO}_2\text{O}_2$ ,  $\text{H}_2$ ,  $\text{HK}$ ,  $\text{K}_2$ . We here get for the first time something like an explanation of basicity. I need not detain you by describing the subsequent discoveries in the same direction made by Williamson and by Gerhardt and Chiozza. They are all explicable only by means of Williamson's principle of what we should now call multivalent radicals, or radicals one atom of which replaces more than one atom of hydrogen.

The applications of this principle to acids and salts are very well summed up in an article by Odling, published in 1855. This article is specially interesting as containing the first use of the marks of valency— $\text{H}'$ ,  $\text{O}''$ ,  $\text{SO}_2'''$ ,  $\text{PO}'''$ , &c. We have seen that Gerhardt used the equivalents—not the atoms—of the metals in his formula of salts. Odling shows how, by marking the replacing value of the atom of the metal, we can write formulæ giving all that Gerhardt's formulæ give, but in accordance with the atomic theory. This restoration of the atoms of metals to their place in formulæ could not then be complete, for much remained to be done in the way of ascertaining the true atomic weight of most metals; but this paper by Odling led the way to a really scientific view of basic salts, and of salts of one base and more than one acid. The multivalence of the metallic radical has the same relation to what may be called the acidity of bases, as the multivalence of the salt radical has to the basicity of acids.

I need not remind you how the idea of the valence, or, as it was usually called, atomicity of radicals and of atoms, grew until Kekulé, by a great stroke of genius, gave it a perfectly general application in the theory of the concatenation of atoms.

We may now consider the new criteria of basicity which the discoveries and generalisations I have sketched made possible. Liebig's criterion was the formation of salts with more than one base. The polybasic acid contains more than one atom of hydrogen replaceable by metals; these can be replaced independently, and thus the number of such hydrogen atoms, that is the basicity of the acid, ascertained. The difficulty is to distinguish between such salts and real double salts—compounds of two distinct salts. Liebig saw the difficulty, but could give no satisfactory solution of it. The discovery of derivatives of an acid, other than salts, from which the acid could be recovered, gave new criteria, much less liable to ambiguity. Thus the compound ethers in which H of the acid is replaced by  $C_2H_5$  give far more secure evidence than the salts, for while we have double salts, such as  $MgCl_2$ ,  $2NH_4Cl$ , we have not analogous compounds of  $C_2H_5Cl$  and chlorides of metals. The existence therefore of salts such as  $KC_2H_5X''$ ,  $K_2C_2H_5X'''$  derived from acids  $H_2X''$ ,  $H_3X'''$  is practically satisfactory evidence that the acids are dibasic and tribasic respectively, even if  $X''$  is divisible by two, and  $X'''$  by three.

Similarly, the formation of amidic acids, although not so generally applicable, is equally satisfactory, for if  $R' - OH$  can combine with  $R' - NH_2$ , the compound will certainly not be an acid; so that the existence of  $R'' \begin{smallmatrix} OH \\ \diagup \\ NH_2 \end{smallmatrix}$  as a monobasic salt-forming

acid derived from an acid  $R'' \begin{smallmatrix} OH \\ \diagup \\ OH \end{smallmatrix}$ , with a salt such as  $R'' \begin{smallmatrix} OK \\ \diagup \\ OK \end{smallmatrix}$  proves this acid to be dibasic, even if  $R''$  be divisible by

two. The same is true of such chlorides as Williamson's  $SO_2 \begin{smallmatrix} Cl \\ \diagup \\ OH \end{smallmatrix}$ , derived from sulphuric acid, and Peligot's salt

$CrO_2 \begin{smallmatrix} Cl \\ \diagup \\ OK \end{smallmatrix}$  similarly proves the dibasic character of chromic acid.

There is a very interesting and important class of substances connected, like the amidic acids and acichlorides, with those acids in which the replaceable hydrogen is directly united to oxygen. For the OH containing the replaceable hydrogen we can substitute

$\text{NH}_2$  or  $\text{Cl}$ , obtaining the amide or the acichloride, and if the acid contains more than one such  $\text{OH}$  the substitution may be total or partial. So also we can, directly or indirectly, replace the  $\text{OH}$  by a hydrocarbon radical such as  $\text{CH}_3$  or  $\text{C}_6\text{H}_5$ ; and if the acid contains more than one such  $\text{OH}$  this may also be done totally or partially, the basicity of the substance being diminished by one each time the operation is performed, thus  $\text{H}-\text{O}-\text{NO}_2$  is mono-

basic,  $\text{C}_6\text{H}_5-\text{NO}_2$  is neutral;  $\begin{array}{c} \text{H}-\text{O} \diagup \\ \text{H}-\text{O} \diagdown \end{array} \text{SO}_2$  is dibasic,  $\begin{array}{c} \text{C}_6\text{H}_5 \diagup \\ \text{H}-\text{O} \diagdown \end{array} \text{SO}_2$

is monobasic,  $\begin{array}{c} \text{C}_6\text{H}_5 \diagup \\ \text{C}_6\text{H}_5 \diagdown \end{array} \text{SO}_2$  is neutral;  $\begin{array}{c} \text{H}-\text{O} \diagup \\ \text{H}-\text{O} \diagdown \end{array} \text{PO}$  is tribasic,

$\begin{array}{c} \text{C}_6\text{H}_5 \diagup \\ \text{H}-\text{O} \diagdown \end{array} \text{PO}$  is dibasic,  $\begin{array}{c} \text{C}_6\text{H}_5 \diagup \\ \text{C}_6\text{H}_5 \diagdown \end{array} \text{PO}$  monobasic, and  $\begin{array}{c} \text{C}_6\text{H}_5 \diagup \\ \text{C}_6\text{H}_5 \diagdown \end{array} \text{PO}$  is

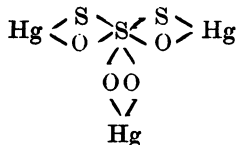
neutral. It is worth while noting that  $\begin{array}{c} \text{C}_6\text{H}_5 \diagup \\ \text{C}_6\text{H}_5 \diagdown \end{array} \text{P} \begin{array}{l} \diagup \text{OH} \\ \diagdown \text{OH} \end{array}$  is known,

but it has no acid properties.

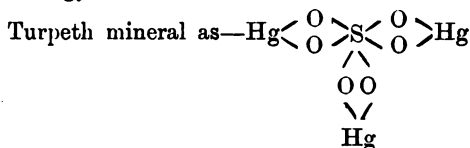
Let us apply these criteria to some cases in which doubts have been expressed as to basicity. It has been said that many of the compounds of nitrogen correspond closely to similarly-constituted compounds of phosphorus; that, as we have a tribasic orthophosphoric acid as well as a monobasic metaphosphoric acid, we should expect to have a tribasic orthonitric acid too; and some chemists have thus been led to look for and find salts of tribasic orthonitric acid, such as the bismuth nitrate,  $\text{BiNO}_4$ . Similarly, sulphuric acid forms with water compounds having the formulæ  $\text{H}_4\text{SO}_5$  and  $\text{H}_6\text{SO}_6$ , and some chemists have been inclined to look upon these as tetrabasic and hexabasic acids, and to find salts for them, such as the body long known as Turpeth mineral,  $\text{Hg}_3\text{SO}_6$ .

The question is—Can we so apply our criteria as to settle the basicity of these acids? The oxygen ratio is in favour of the tribasic orthonitric acid and the hexabasic orthosulphuric acid—the salts have the dualistic formulæ,  $\text{Bi}_2\text{O}_3$ ,  $\text{N}_2\text{O}_5$ , and  $3 \text{ HgO}$ ,  $\text{SO}_3$ . But we have no partial ethers of corresponding composition, and no corresponding partial amides. In the analogous case of supposed orthocarbonic acid we have, indeed, an ether,  $\text{C}(\text{OC}_2\text{H}_5)_4$ , but no salts,  $\text{C}(\text{OC}_2\text{H}_5)_3\text{OK}$  or  $\text{C}(\text{OC}_2\text{H}_5)_2(\text{OK})_2$ . As already pointed out,  $\text{C}_6\text{H}_5-\text{NO}_2$  is neutral, and there is no indication that it is a well-concealed anhydride of a dibasic acid, so that we must look for the reason for the composition of these salts elsewhere than in a basicity of 3 or 6; and when we look at the salts presented

to us as normal orthonitrates or normal hexabasic orthosulphates, we are struck by the fact that the metals in them are *all* metals which by habit and repute give basic salts. We have not only  $3\text{HgO}$ ,  $\text{SO}_3$  or  $2\text{HgO}$ ,  $\text{HgSO}_4$ , but also  $2\text{HgS}$ ,  $\text{HgSO}_4$ . Are we really to consider this well-known substance as—



analogy would almost force us to do so if we are to represent



and consider  $2\text{HgS}$ ,  $\text{HgSO}_4$  as a salt of a new kind of thiosulphuric acid? Basic salts and thiobasic salts occur with nearly every mercuric salt, and a new hypothesis would be needed for each of them. Whereas the straightforward view that mercury forms basic salts, and that these salts have the general formula,



and  $\text{Hg} < \begin{array}{c} \text{S} - \text{Hg} \\ \text{S} - \text{Hg} \end{array} > \text{SO}_4 \text{,}$  while it does not explain the facts, at all events states them in a general form.

Similarly the notion of bismuth orthonitrate separates the substance precipitated by water from normal bismuth nitrate from the substances similarly precipitated by water from other normal salts of bismuth, such, for instance, as  $\text{BiOCl}$ , whereas if we give them all the general formula  $\text{O} = \text{Bi} - \text{X}$ , we see their relation to each other and to salts of antimony, such as  $\text{SbOCl}$  and tartar emetic.

The broader view which we can now take of basicity and atomicity, and the intelligible representation of basic salts, rendered possible chiefly by Odling's reintroduction of the atoms of metals into the formulæ of salts, should preserve chemists from such fantastic views as those we have been discussing. The case of orthocarbonic acid and orthoformic acid is somewhat different. There we have real definite compounds having undoubtedly the formulæ  $\text{C}(\text{OC}_2\text{H}_5)_4$  and  $\text{HC}(\text{OC}_2\text{H}_5)_3$ . Are these truly ethereal salts of tetrabasic and tribasic acids,  $\text{C}(\text{OH})_4$  and  $\text{HC}(\text{OH})_3$ ? I

say, certainly not; no more than  $\text{CCl}_4$  and  $\text{HCCl}_3$  are acichlorides. We know that in many compounds chlorine can be replaced by  $\text{OC}_2\text{H}_5$ , where the corresponding compounds of OH are unknown or unstable, and the corresponding compounds of OK are certainly incapable of existence. It is not the existence of an ether  $\text{X}(\text{OC}_2\text{H}_5)_n$  which proves that  $\text{X}(\text{OH})_n$  is an  $n$ -basic acid; it is the existence of an  $(n - p)$ -basic acid  $\text{X}(\text{OC}_2\text{H}_5)_p(\text{OH})_{n-p}$  which proves  $\text{X}(\text{OH})_n$  to be  $n$ -basic. You must show that after you have eclipsed some of the OH's by turning them into  $\text{OC}_2\text{H}_5$ 's, the rest of them still contain hydrogen replaceable by metal. In counting them off you must see that those which remain retain their character, otherwise the existence of acetal would prove aldehyde to be the anhydride of a dibasic acid. In all these speculations we must keep our eyes open to facts all round us, and not allow ourselves to be blindly led by some one rule, however plausible.

A much more difficult case arises when we turn to oxyacids, and in particular to the phenol acids. What is the basicity of salicylic acid? The question really is—Is phenol an acid? If it is, then salicylic acid is dibasic. If the owner of a house with a back-green is to be called a landed proprietor, then no doubt the man who has a large estate and also a house with a back-green is doubly a landed proprietor; it is really a question of degree. We do not feel the difficulty so much when we have to compare, say, phenol with benzoic acid. We can admit that both are acids, one much stronger than the other; but when we have both cases in one, the large property so overshadows the back-green that we feel that there is something ludicrous in speaking of them as two of the same kind of thing. In sulpho-acetic acid,  $\text{H}-\text{O}-\text{SO}_2-\text{CH}_2-\text{CO}-\text{OH}$ , we have two replaceable atoms of hydrogen, different in character, but not so different as to be incomparable, and we feel no awkwardness in calling sulpho-acetic acid dibasic. The same is the case with thiosulphuric acid,  $\text{H}-\text{O}-\text{SO}_2-\text{S}-\text{H}$ , and sulphurous acid,  $\text{H}-\text{O}-\text{SO}_2-\text{H}$ , but when the difference is great, as in salicylic acid, we feel that it somewhat strains the nomenclature to use the term dibasic. What we have really to do is to look at such questions from a common-sense point of view, and perhaps my analogy of the back-green and the £10,000 a year estate may help us to do so.

Before closing our review of the history of the idea of basicity, we must look at its relation to electrolysis. And this leads me

back to Williamson's papers on Etherification. In the first of these papers Williamson uses the remarkable words—"In using the atomic theory, chemists have added to it, of late years, an unsafe and, perhaps, unwarrantable hypothesis—namely, that the atoms are in a state of rest. This hypothesis the author of the present paper discards, and reasons upon the broader basis of atomic motion." He explained his view with some detail; it is that, in a drop of hydrochloric acid, each atom of hydrogen does not remain united to one particular atom of chlorine all the time, but that constant exchanges take place, and that the same thing happens with other salts in solution. Double decomposition thus becomes easily intelligible. If I may be allowed a far-fetched simile, let us suppose a number of fair-haired men on white horses in one field, and a number of black-haired men on brown horses in another field, and that in both cases there is a great deal of interchange of horses; there is no visible change, because if two men change horses, we have still two fair men each on a white horse. But if we take away the fence between the fields and let the two sets mix, and the same process of exchange goes on, it is sure to happen that a man who has just got off his white horse will find a riderless brown horse near him and will get up on it, and thus double decomposition will take place. Williamson points out very clearly how the removal of one of the products of double decomposition, by its being insoluble or volatile, enables the decomposition to go on to the end, instead of settling into a balanced condition.

Some years later Clausius published views of the same kind, with this addition that he assumed that the exchange will be more frequent as the temperature is higher, and showed how the principle that the temperature is really an average of the condition of the molecules, which are not all in the same state, affects the question.

Arrhenius—taking this Williamson-Clausius theory into consideration, along with the laws of electrolysis discovered by Faraday, and Hittorff's remarkable generalisation, "Electrolytes are Salts"—developed a new chemical theory of electrolysis. His views have been extended and illustrated by several investigators, among whom I may specially mention Ostwald, whose work and writings have done much to extend the knowledge of the new theory, and to commend it to many who at first looked on it with doubt. I can here give only a very brief and imperfect sketch of it. If the metal and the rest of the salt (the salt-radical) are

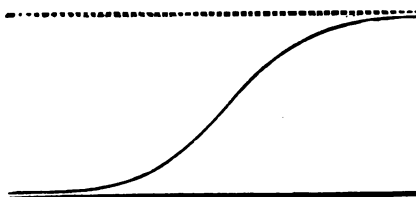
often parting company to unite with other atoms of salt-radical and metal, it must be that the solution contains free atoms of metal and of salt-radical. To take our analogy: a man gets off his horse, and does not find another just at hand; a horse is left riderless and walks away, and it is some time before a horseless man meets it. The more dilute the solution is—in our simile the more other moving things, not horses or men, there are in the field—the greater the chance of the separate parts of the molecule (the dismounted men and the riderless horses) not meeting soon their complement; in other words, the greater will be the proportion of disunited to united molecules.

The readiness with which double decomposition takes place will be greater, *cæteris paribus*, the greater the disunion. Now the electrolytic conductivity of a salt solution varies with the readiness of its salt to take part in double decomposition, so that the more the ions (the metal and the salt-radical) are separated, the greater the electrolytic conductivity. If now we assume, as we must, that the ions in separating retain their electric charge—positive on the metal, negative on the salt-radical,—we have an explanation of electrolysis; the positive ion (metal) being attracted to the negative electrode (cathode), and the negative ion (salt-radical) being attracted to the positive electrode (anode). When they arrive at the electrode, if the difference of potential of the electrodes is sufficient, they give up their charge and appear as substances—either as the ions themselves, if they are capable of existing as such in the presence of water, or as the secondary products of electrolysis.

What interests us now is that the electrolytic conductivity gives us a measure of what has been called the dissociation of the ions, and that with the same degree of dilution this dissociation is greater, the greater is the readiness with which the salt enters into double decomposition. When the metal is hydrogen the salt is the acid, and its readiness to enter into double decomposition is a measure of what we are accustomed to call, somewhat vaguely, the strength of the acid, so that the stronger the acid the greater is its electrolytic conductivity.

We may now look at the effect of dilution. A great help to understanding this is an imaginary experiment described by Ostwald:—Let us suppose a vessel with square bottom and four vertical sides, two opposite to each other being of platinum, the other two of glass. Connect the two platinum sides to the two wires

coming from a galvanic battery. Now put into the vessel a strong solution of an acid, and test the electrolytic resistance; dilute with water, and as the dilution proceeds test the resistance. You will see that just as the dilution increases, the area of the electrodes increases; so that what is done in real experiments by calculation is supposed in this imaginary experiment to be done for us by the form of the apparatus. In the case of all acids it is found that the conductivity as thus determined (the relative conductivity) increases with dilution, and approaches asymptotically to a final value. On Arrhenius' theory this final value is that of the solution in which the whole of the salt is separated into its ions. If we construct a curve with the logarithm of the dilution as abscissa and the molecular conductivity as ordinate, we get for monobasic acids a form like—



All monobasic acids have the same curve, but in different acids the dilution corresponding to the same point is different. For dibasic acids we have a different form. At first, dilution seems to act as it does in monobasic acids, there is the same appearance of approach to a final value, but a second start is made, and the real asymptote is seen to have an ordinate twice as great as that of monobasic acids.

I have no wish at the present time to discuss the validity of Arrhenius' theory, but we must admit that the measurement of the relative electrolytic conductivity gives us a new criterion for the basicity, as it also gives us a method for determining numerically the "strength" of an acid. It is impossible in this connection to avoid the mention of Raoult's methods for the determination of the molecular weight of soluble bodies, and of Van't Hoff's investigations on osmotic pressure, the results of which in the case of electrolytes show a marvellous agreement with what we should expect them to be if Arrhenius' theory were true; but time does not allow of more than this allusion.

There is one point which I have not spoken of, but which is perhaps worthy of discussion.  $\text{H}_3\text{PO}_4$  is tribasic; it is quite easy to replace two atoms of hydrogen by sodium; mix  $\text{H}_3\text{PO}_4$  in aqueous solution with sodium carbonate in sufficient quantity, and the thing is done. But the same method is not adequate for the replacement of the third atom of hydrogen; more severe measures must be taken to do that. Are we therefore to conclude that two of the hydrogen atoms have a different relation to the  $\text{PO}_4$  from that which the third has? Let us take a similar case in ordinary business matters. A man has three shillings—quite similar; he does not know any difference between them; he is equally attached to them all. A seller of, let us say, books offers him a book for a shilling; he looks at the book, and buys it. The seller of books seeing that this operation, the replacement of a shilling by a book, has been easily effected, tries to do it again; he finds that the operation is not so easy now; the state of matters is changed. That is no proof that the man had a less regard for the particular shilling he paid away than for the other two; he gave the first that came to his hand; but he now regards the two remaining shillings in a somewhat different light because he has only two, and if the book man should succeed in getting him to take another copy for another shilling, he had better go away with his gains and not try a third time. And yet the increasing difficulty of performing the same operation would be no argument in favour of the view that the man had originally, when he had the three shillings, any difference of regard for one of them than for the others.

I have tried to lay before you an account of the origin and development of the idea of basicity. This has led us through much of the history of chemical theory, and I have found it difficult to give what is necessary for our purpose without becoming diffuse, and wandering into regions of chemical history, somewhat apart from our subject. I hope the chemists in the Society will not think my treatment of the subject trivial because I have told them nothing they did not know already, and that those who have not made chemistry a special study have not found it dull because I have not had time to illustrate it so fully as I should have wished.

VIII.—*On the Conversion of Ordinary Gas Shades into Regenerative Lamps.* By DANIEL R. GARDNER.

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[Summary of Paper read before the Society, 18th December, 1889.]

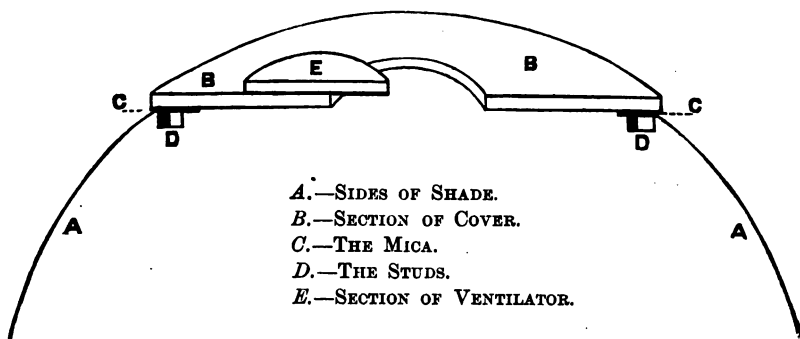
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THE author stated that he was led up to the invention which he was about to describe by his experience in connection with the consumption of smoke in boiler furnaces. Many years ago, after having been summoned for creating an alleged nuisance by smoke, he investigated the principle of consuming, or rather of preventing smoke; and he found that highly-heated air, properly applied in the furnace, was all that was necessary. He afterwards proceeded to bring this principle to bear in the production of a regenerative gas-lamp suitable for shops, halls, &c. He studiously avoided the method in which other inventors had carried out the principle of regeneration in gas-lamps, and was led to supply the air from the bottom of the shade alone, and to control the draught by means of a damper at the top of the funnel, which, by being screwed up or down, adapted the lamp for burning gas of any quality or at any pressure. In like manner he carried out the same principle in ordinary gas globes or shades.

With the view of explaining the science of increasing light for illuminating gas, the author quoted from an article in Ure's "Dictionary of Arts, Manufactures, and Mines," to show that the proper burning of illuminating gas depended upon certain physical and chemical conditions, the due observance of which was of great importance in the development of a maximum amount of light. Chief of these was the prevention of the escape of any particles of carbon unconsumed. He also referred to Dr. Frankland's Argand burner, fitted with a double chimney for the purpose of highly heating the air, with the result that when 3·3 cubic feet of gas were consumed per hour with the single chimney, 13-candle power was yielded by the gas, whereas by employing the double chimney 21·7-candle power was developed. The double chimney was tried by the author before he was aware of its previous use; but he found it to be valueless, as the double glass considerably obstructed the light, and the dust and moisture carried in by the current of air further obscured it. He then resorted to the ordinary glass shade, and discovered that, by materially diminishing the outlet, the flame considerably increased in size. His thoughts were at once directed

towards the materials and form best suited for a cover to the shade. Asbestos was tried, by moulding or fitting it on the shade; but when a high temperature was maintained, the shades would occasionally crack. Latterly, after making various attempts to overcome this and other difficulties, the author hit upon the expedient of using small plates of mica between the asbestos and the glass shade as non-conductors of heat. Although he had subjected the shades to very severe tests, he had not since broken one. The cover might now be considered to be as simple and perfect as it was possible to make it, as it suits all qualities of gas, the different pressures, and the various sizes of burners, and could be used with the present shades and gas-fittings by merely placing it on the shade and adjusting the regulator.

The following is a brief description of the cover in the form now arrived at by the inventor:—Sheet asbestos, specially prepared for the purpose, is cut into discs varying from 4 up to  $7\frac{3}{4}$  inches in diameter, and rising  $\frac{1}{4}$  inch to each size, so as to suit all the different sizes of shades. In order to hold the cover in its place, three asbestos studs are fixed on its lower surface, moving in an eccentric, which allows the cover to be most perfectly fitted. Round the lower edge there are half-a-dozen discs of mica fixed. These act as non-conductors between the glass shade and the cover. In the centre of the cover there is punched out an opening  $1\frac{3}{4}$  inches in diameter; and the disc so removed is fixed by means of a stud to the cover at one side of the opening on which it turns—thus becoming a valve to regulate the size of the aperture according to the quality and quantity of gas used.





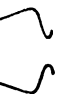
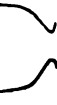



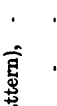

The author stated that he had recently called upon Mr. W. Foulis, the General Manager of the Glasgow Corporation Gas Department, to confer with him on the invention. That gentleman at once heartily took up the matter, and volunteered to have it

subjected to a thorough scientific testing photometrically by Mr. D. Terrace at the Dawsholm Gas-works. The author then briefly referred to some of the papers on "The Economical use of Gas," by Mr. Terrace and the late Dr. Wallace, and went on to state that the former gentleman, in his Presidential Address to the North British Association of Gas Managers (Glasgow, 1888), in showing that improvement was not to be had from burners, said that, in testing several of the devices intended to improve the ordinary open gas-flame, he found no increase in luminosity per cubic foot of gas consumed from that given by the union-jet burner consuming 5 cubic feet per hour at 0.5 inch pressure. At this stage Mr. Gardner directed the attention of the members to a table in which were embodied the results of a series of tests made by Mr. Terrace, with the view to ascertain the loss of light with small burners and high pressure; also to a table showing the loss of light resulting from using different kinds of shades. He stated that if the extremes of the two tables were taken together, the loss of light was something like 91 per cent.

In summing-up, the author said he found from the different authorities that (1) highly-heated air produces complete combustion, and gives an increased luminosity to the carbon contained in the gas; and (2) that it is likewise necessary to retard the flow of gas. The question came to be: "Had those two points been attained by the application of the asbestos cover?" One experiment would be quite sufficient to demonstrate this. He caused a cloud of smoke from a piece of brown paper to enter the shade, which showed a quiet condition of the atmosphere around the flame, and consequently a retardation of the flow of gas at the burner, while the temperature of the surrounding air was raised to the point desiderated by Dr. Frankland for the combustion of the light carburetted hydrogen that passes off unconsumed from an ordinary gas-flame. The author stated that he had burned a number of lights with the covers on in a small room for a couple of hours, and on returning to the room from the fresh air, he could not perceive the slightest unpleasantness in the atmosphere; whereas if the shades had been without covers the air of the room would have been both disagreeable and unhealthy.

The illuminating power attained by Glasgow gas by the use of the Gardner asbestos cover had been tested by Mr. Terrace, under the direction of Mr. Foulis; and the results were shown in a table exhibited, of which the following is a copy:—

RESULTS OF TESTS WITH COVERED AND UNCOVERED SHADES AND OPEN FLAMES.

DESCRIPTION OF SHADES (CLEAR).	Tested with Union Jet Burners.				Illuminating Power corrected to Five Cubic Feet.			Increase Per Cent. with Cover.	
	Pressure.	No. of Burner.	Consumpt per Hour.	Open Flame.	Shades without Covers.	Shades with Covers.	Open Flame as Standard.	Shade without Cover as Standard.	Per Cent.
Comet, ... 	$\frac{1}{16}$	8	5.00	22.19	20.91	24.49	10.36	17.12	
Squat, ... 	$\frac{1}{16}$	8	5.00	22.19	19.40	24.50	10.41	26.29	
Nelson, ... 	$\frac{1}{16}$	8	5.00	22.25	20.25	24.61	10.60	21.53	
Queen Anne, ... 	$\frac{1}{16}$	6	3.75	20.15	17.10	22.41	11.21	31.05	
Do., - - - 	$\frac{1}{16}$	4	2.75	15.49	13.25	18.83	21.56	42.11	
Squat, - - - 	$\frac{1}{16}$	4	5.08	11.41	9.89	13.66	19.72	38.12	
Do. (small), - - - 	$\frac{1}{16}$	4	5.08	11.41	10.27	14.75	29.27	43.62	
The following results are partially due to reflection:—									
Queen Anne (fern pattern), - - 	$\frac{1}{16}$	8	5.00	18.88	16.81	29.03	53.76	72.70	
Do. (clear), - - - 	$\frac{1}{16}$	4	2.75	10.22	9.59	21.15	106.90	120.50	

Proceeding, the author stated that the tests in the first place were taken in the most favourable conditions for the open flame, and in a manner that is never used by the public, namely, in a horizontal line with a No. 8 burner, consuming 5 cubic feet of gas per hour at 0·5 inch pressure in a perfectly calm atmosphere. Comparing the covered shade in such unfavourable circumstances with the open flame, an increase of light was nevertheless obtained of from 10·36 to 10·60 per cent. With a No. 4 burner and 1·5 inch pressure under the same conditions, 29·27 per cent. was gained over the open flame; and on comparing the covered with the uncovered shades as great a difference as 43·62 per cent. more light was arrived at. Blackened covers were tried in order to see if the increased luminosity was due to reflection, but they also showed the same good results. Testing now with the ordinary pressure and burners at an angle of 45 degrees, being the usual position of a light in relationship to the person using it, the flame from a No. 4 burner in the covered shade gave 106·90 per cent. more light than the open flame, while the covered compared with the uncovered shade brought up the illuminating power of the gas in favour of the former to 120·50 per cent.

In conclusion, the author said that, looking at the immense daily waste of gas (amounting, according to the late Dr. Wallace, to £130,000 per annum for Glasgow alone, fifteen years ago), he thought it would be well for the Glasgow Corporation Gas Trust to lead the way in promoting its economical consumption, by instituting a Lighting Department that would superintend the burning of the gas, and not allow the consumers to waste, as many did at present, 91 per cent. of the gas which they paid for, not to speak of this new improvement of over 100 per cent. more light added. If such measures were adopted, electricians would find themselves a longer way behind than they ever dreamt of, and the consumer would find gas-light at less than half cost, with double the amount of illumination, and an atmosphere harmless to health as well as to ceilings, pictures, and decorations. He had burned gas with the covers for the last two winters with the best results. The flame gave a beautiful, soft, steady light, peculiarly agreeable to the eyesight, so that close reading, writing, sewing, &c., carried on in proximity to it, were more pleasing and less tiring and hurtful than with the light derived from the usual flickering flame.

There was very little time allowable for the discussion of the subject raised by the paper; but, as Mr. Foulis was present,

he was called upon by the Chairman to make a few remarks. This gentleman said he had been much interested in the invention, the results of the testing of which had greatly surprised him. The gas authorities of the city and himself were always ready to encourage every feasible attempt to improve the illuminating effect of the gas supplied to the consumers; and in this spirit he had authorised Mr. Terrace and his assistant (Mr. Duncan) to test Mr. Gardner's invention most thoroughly. The results were seen both in the table exhibited and in the lamps with which Mr. Gardner had been experimenting that evening. He (Mr. Foulis) was not, however, yet prepared to admit that the whole of the effect, if even any appreciable amount of it, was obtained by the increased heat of the air used in the combustion of the gas. He rather thought it was almost wholly due to the quietness of the atmosphere within the shade. Having alluded to the experimental investigations which Mr. John Methven had lately been conducting in a somewhat similar direction, but with Argand burners with the use of chimneys necessary for them, he remarked that he had been deeply interested in Mr. Gardner's paper and the experiments, and felt that the members of the Society were much indebted to him for having brought the subject before them.

IX.—*The Territorial Expansion of the British Empire during the last ten years.* By THOMAS MUIR, LL.D., President of the Geographical and Ethnological Section.

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[Read before the Society, 11th December, 1889.]

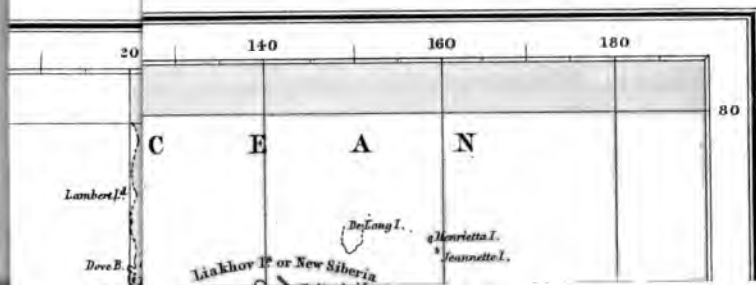
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(WITH MAP.)

It would have been more in accordance with precedent, if I had tried to give you this evening an account of the main geographical discoveries made during my predecessor's term of office, or if I had chosen a particular country not yet wholly explored, and had recounted to you, in chronological order, the labours of those who had attempted to find out its secrets. In choosing, instead, the subject of the recent extensions of our empire, I have taken what, from a strictly geographical point of view, would be considered lower ground.

At the same time the subject, as you will freely own, is an important one. All that concerns the growth of a state ought in every epoch to be of interest to the citizens of the state; and in a time like the present, when even the meanest amongst us has come to have a share in the government of the country, a double interest in the matter may fairly be expected. A purely business view of the question leads to the same conclusion; for, as the British foreign dependencies have in great part had their origin in the enterprise of British manufacturers, traders, and merchants, prosperity in trade and the consequent material well-being of the people are seen to be intimately connected with the question of the curtailment or extension of our territory abroad. When, lastly, we consider that of recent times more than half of our troubles as a nation have arisen, not in the home country, but in connection with the outlying portions of the empire, we cannot but own that an hour or so devoted to the consideration of the last ten years' territorial increase may be time well spent.

My only regret, indeed, is that the subject is much too extensive for adequate treatment in the time at our disposal. A course of three lectures by well-informed specialists, one corresponding to each of the three great spheres of enterprise—Africa, Southern





Asia, and the Pacific,—would have been more commensurate with the magnitude of material at disposal ; nor would the field then by any means have been exhausted. This implies, you will observe, that what I am about to present to you is but a sketch. If, however, the effect shall be to awaken interest in the subject, to convey a little desirable information to those of you who may have but scanty leisure for acquiring it otherwise, and to refresh the memories of those who, on the other hand, make such things a study, I shall be well satisfied. It is told of Lord Palmerston that, on first going to the Colonial Office after his appointment as Secretary for the Colonies, he began work by directing one of the permanent officials to bring down the map and show him where all “these places” were. I aspire to little more on the present occasion, so far as pure geography is concerned, than to play the rôle of the member of the Colonial Office staff, and the best-informed amongst you will not, I am sure, feel aggrieved if you are asked to put yourselves for a little in Lord Palmerston’s position, and be told “where those places are.” As for the historical narrative in regard to them, I know of no writer who has taken the pains to unearth the necessary facts, to test their accuracy, and to place them in order as I have tried to do.

First of all, then, it is necessary that we glance for a moment at the extent of the empire before the additions in question were made.

In the New World the division of territory has remained pretty much as it is, so far as Britain is concerned, for a good many years. The boundary between Canada and the United States on the east was settled by the Ashburton treaty of 1842, and on the west by the Oregon treaty of 1846 ; and as for the smaller possessions—Newfoundland, Barbados, the Bermudas, the Bahamas, Leeward Islands, Jamaica, Windward Islands, Honduras, Trinidad, Guiana, and the Falkland Islands,—the last-mentioned and last-acquired came into our possession so long ago as 1833. The Western hemisphere may thus be left altogether out of account.

In Europe, as you are well aware, we have ceased from troubling for a still greater length of time. Of the three possessions outside the British Isles—namely, Gibraltar, Malta, Heligoland,—the last was captured from the Danes in 1807.

In Asia, on the other hand, the circumstances have been such

that standing still has been well nigh impossible ; and, as a matter of fact, since 1615, when at Surat the first settlement of the East India Company was founded, the growth of British territory has never for any lengthened period been interrupted. Besides India proper, the outcome of this has been a long string of dependencies—Penang, Ceylon, Singapore, Malacca, Aden, Kuria Muria Islands, Hong Kong, Labuan, Lower Burmah, Perim, Cocos-Keeling Islands, Kamaran Island, Andaman Islands, Kowloon and Lema Islands, Nicobar Islands, the Dindings, and the three Malay States of Perak, Selangore, Sunjei Ujong. The great majority of these have been acquired during the lives of people who are not yet old, and the last three so late as 1874. Even between 1874 and the beginning of our ten-year period the same process of absorption was going on. I need but mention to you the name of one of these acquisitions, Cyprus, surnamed “Little,” to recall to you all the circumstances connected with the transaction. It is not so generally known, however, that almost at the same time an equally important addition was made for a quite similar purpose and on closely resembling conditions. The last Afghan war, you will remember, was just then coming to a close, and the future safe-keeping of the Ameer’s territory had to be provided for. In the opinion of the strategists this could not be done if certain districts bordering on the Bolan Pass were not in the hands of the Indian military authorities. Accordingly, in the Treaty of Gandamak, signed in 1879, the following clause occurs:—

“That the districts of Kuram and Peshin and Sibi . . . shall remain under the protection and administrative control of the British Government . . . the revenue of these districts, after deducting the charges of civil administration, shall be paid to his Highness the Ameer.”

The wording, you will observe, brings out the analogy with Cyprus very distinctly. I may add here that the districts mentioned have since then been pierced by the important and much-talked-of railway to Quetta, and, since 1887, been governed as part and parcel of the Indian Empire under the name of British Baluchistan.

Turning now to Africa, let us see how affairs had progressed there. Except for the slower and more irregular rate of increase, the case will be found not very unlike that of Asia. The formation of the first settlement on the Gambia belongs to about the same period as that of the first settlement in India, and before we reach 1880 the list is a tolerably lengthy one, namely:—Gambia Mouth, St. Helena, Cape Coast Castle, Sierra Leone, Cape Colony,

Mauritius and its dependencies, Ascension, ~~Musha~~ <sup>Muscat</sup> Island, Natal, Danish Gold Coast, Lagos, Sherboro Island, ~~Basito~~ <sup>Basuto</sup> Land, Dutch Gold Coast, Griqualand West, all the Transkeian Territories with one exception, and Walfisch Bay. The acquisition of the last-mentioned was made in 1878. The year before, 1877, there took place a memorable annexation, which deserves special mention; and which doubtless you anticipate. The Boer Republic to the north-east of the Vaal river having got into various difficulties, and being in a state of hopeless bankruptcy, our Government, feeling that something had to be done to maintain an executive authority, stepped in, and, with the cheerful assent of a large proportion of the more intelligent inhabitants, proclaimed British sovereignty. The cause and the mode of undoing this act, and the troubles which followed from it, are still familiar to us all, and need not be recalled. They belong, moreover, to a later date.

The only remaining division of the globe we have now to consider is Australasia and the Pacific. Here settlement and annexation began late. It was not indeed until after Britain had lost her first North American colonies, and had in 1783 avowed the loss, that she began to turn her attention to Australia. Between then and 1880, however, rapid progress had been made, the list of possessions consisting of the whole Australian Continent (with its dependencies, Norfolk Island and Lord Howe Island), Tasmania, New Zealand (with its dependencies the Auckland Islands, the Chatham Islands, the Antipodes Islands), and Fiji. The youngest of these is Fiji, which came into British possession in 1874.

The exact state of matters at the beginning of our period being thus made clear, we are now in a position to take up in historical order the additions of the past ten years, and are the better able to appreciate their importance, and to understand their bearing upon previous work.

The list opens quite modestly with a small island in the Western Pacific. In the year 1879 the island of Rotumah being much shaken by ecclesiastical disturbances, which culminated in something like actual warfare between the two opposing sects (Roman Catholics and Wesleyans), the chiefs approached the Government of Fiji with a petition for annexation to Great Britain. The petition was granted in 1880—the island being united to the Colony of Fiji. The population, about 2,500, is well advanced in

civilisation; the land is marvellously fertile; and its men are noted in the Pacific as first-rate seamen.\*

The next annexation was of a very different character; the story of it recalls the extensive and daring schemes of the merchant adventurers of Queen Elizabeth's time. In the north of the island of Borneo, the second largest island on the globe, there has existed for generations back a Malay state called Brunei. Indeed, it is probable that from the name of this state, which was once much more extensive than now, the name Borneo was given to the whole island by early European sailors. For many years the condition of Brunei has been anything but flourishing. Before the time we have arrived at, it had handed over to its neighbour Sarawak the government of a large slice of its territory, and had parted with the island of Labuan to Britain. Like Turkey in Europe, Brunei in Borneo has been the "sick man." Its only consolation in decay could be that the state of Sulu, which had territory bordering on it, was not much more robust. Head-hunting, piracy, and general lawlessness prevailed in both. Now, in the year 1877, the happy thought occurred to some eastern merchant that the Sultans of Brunei and Sulu might be in part bought out. Without much delay the project became a reality. For a money consideration the two Sultans surrendered absolutely all their rights to a territory with several hundred miles of sea-board; and in 1878 the British North Borneo Company, originated by Mr. (now Sir) Alfred Dent, became both owners and rulers. The Company's object, it may be noted, was not that of an ordinary commercial association. It disclaimed, in fact, the name of a trading company, its intention being to put the government of the country on a sound footing, and so allow trade to be carried on in safety by the inhabitants and others. Settlements were made at points on the coast where there was good harbourage; a Governor and magistrates were appointed in order that British justice might be meted out to high and low alike; a police force was organised to prevent and detect crime; explorers were engaged to discover and localise the natural resources—in a word, almost all the departments of a civilised state were attempted to be established in forms suited to the stage of development which the country had reached. The British Government, on being

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\* The only separate publication known to me regarding Rotumah is "Romilly: a true story of the Western Pacific" (Longmans); but see also "Romilly: the Western Pacific and New Guinea," pp. 147-153 (Murray).

approached, were so satisfied with the high standing, administrative ability, and benevolent aims of the directors, and so convinced of the immense good which might result from their endeavours, that they took the extraordinary step in 1881 of granting a Royal Charter conferring powers and rights and privileges comparable only with those conferred on the great companies of the times of Elizabeth and Charles II. It is impossible here to give anything like an adequate sketch of the resources of the Company's territory. It embraces immense forest wealth, great mineral wealth, and thousands of square miles of land suitable for tropical agriculture. If one prominent natural curiosity has to be singled out, the choice may perhaps most fitly fall on the wonderful caves of Gomanton. The following is the description of them given by Sir Walter Medhurst in 1885:—

“The explorer, Mr. H. Pryer, brother to the Resident at Sandákan, came suddenly in the thick forest upon a sheer cliff of limestone 900 feet in height, in which the caves are situated. The entrance to the great cavern is rather over 100 feet wide by 250 feet high, and the roof slopes upward 110 feet more, forming a magnificent natural cathedral some 360 feet in height. The interior is well lighted by two large apertures on the right and left, and the walls are rugged and beautifully tinted with various shades of colours. Circling high above the heads of the explorers were myriads of bats and swifts, the nests of the latter being attached to the sides and roof in incredible quantities, and in seemingly inaccessible spots, but the nest-gatherers had nevertheless planted everywhere the light stages and ladders of cane and bamboo with which they pursue their hazardous occupation. The nests appear to be made by the birds from a soft fungoid growth that encrusts the limestone in all damp situations. It grows about an inch thick, dark-brown on the outside and white on the inside, and it is from the latter portion that the best quality nests are formed. The bird takes the material in its beak, and draws it in a filament backwards and forwards, like a caterpillar weaving its cocoon.\* The most wonderful sight is to watch the bats leave the caves and the swifts return to roost. About 5 p.m. a rushing sound is heard, when innumerable columns of bats may be seen wheeling round in regular order, and circling into the air in a cork-screw flight, until they reach the mouth of the cave, and fly off to their several destinations. Shortly after, the swifts begin to arrive in the same untold quantities, and with similar regularity of motion. At daylight the process is reversed, the swifts going out, and the bats coming home, the latter occupying fully two hours, literally ‘raining’ into the chasm. The birds keep up an intermittent twittering, which, owing to the vast number assembled, sounds like surf breaking upon a rocky shore. The explorers were witness to the process of nest-gathering. The ladders are hung across the most horrible gulfs, and two men take their station upon each, one carrying a light pronged spear, about

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\* This account of the nest-building is not to be relied on.—T. M.

15 feet in length, with a lighted candle fastened just below the prongs. With this the nests are transfixed, and a slight push easily detaches them from the rock, when the second man receives the nests from the prongs and puts them into his pouch."

The commercial value of the caves, I may add, is very considerable. They are leased to a company, and we have it on official authority that birds' nests from them to the value of about £5,000 sterling are exported every year to make soup for the Chinese. The guano of the caves, which has not apparently been turned to account, is reported to be "enormous beyond calculation."

There can be no doubt that, if well governed, British North Borneo has a great future in store for it. Its geographical position is all that could be desired. It faces China, a country whose people are born traders and colonists, and it lies directly on the sea-route between that country and Australia. That it has been well governed and wisely dealt with since coming into British hands, good authorities have repeatedly acknowledged. The single fact that the foreign trade has risen in value from almost *nil* in 1878 to about £350,000 in 1888 is most significant. So also is the fact that on the north side of Sandakan harbour, where in 1878 there were but a few miserable huts, there now stands the town of Elopura, the chief seat of government, with a busy and law-abiding population of several thousands. The exploration which has been accomplished is attested by the company's map, issued in 1888, showing also the division into nine provinces—Aloock, Cunliffe, Dent, Dewhurst, Elphinstone, Keppel, Martin, Mayne, Myburgh—for the purposes of government. All this, and much more that could be referred to, shows that in British North Borneo there is an experiment in progress which deserves the good wishes of philanthropists in every quarter of the world. When we consider that it is being carried on by a mere handful of our countrymen, we may be pardoned for looking on with some pride.\*

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\* The literature of British North Borneo is not very extensive. The writings known to me are :—

1884. Cobb, B. F.: *Journal of Society of Arts.*

Gueritz, E. P.: *Report of British Association*, p. 805.

Do., *Proc. Geog. Soc. of Australasia.*

1885.—Medhurst, Sir W. H.: *Proc. Roy. Colonial Institute.*

Hatton, F., "North Borneo: Explorations and Adventures on the Equator" (Sampson Low, Marston, & Co.).

1886.—Pryer, W. B.: *Report of British Association*, p. 733.

Guillemaud, F. H. H.: "Cruise of the *Marchesa*" (Murray).

From 1881 and North Borneo we pass on to 1883 and the Malay Peninsula. Since the time when the three states, Perak, Selangore, and Sunjei Ujong, were placed under the protection of the Queen, British influence continued steadily to extend, the result being that in 1883 Sir Frederick Weld, the Governor of the Straits Settlements, brought about a treaty with the Nēgri Sēmbilan, by which they also were brought within the protectorate. Their situation is inland, between Malacca on the west coast and Pahang on the east coast. Like most other states of the peninsula, they have valuable deposits of tin.\*

In 1883 there was also an extension of territory, scarcely worth mentioning, by which Sierra Leone became contiguous with Liberia, the Mannah river being fixed as the boundary between them.

The year 1884 saw the birth of a new colonial power, Germany, and with it there came stirring times. Strange to say, the first inkling that such an event was about to happen reached the British public from Australia the year before. For some time Queensland, and indeed Australia generally, had been keeping an eye upon Eastern New Guinea and the adjacent islands. Something like a national feeling had been developing, and, when the future was thought of, the possibility of French or German colonies being planted in the neighbourhood could not but suggest itself as a source of danger. Australia, a continent about five-sixths the size of Europe, began to seem insufficient, and the colonists felt that like their cousins in the United States, they must have a Monroe doctrine, and that their watchword must no longer be "Australia," but "*Australasia* for the Australians." When, therefore, early in 1883, certain rumours reached the Queensland Premier, Sir Thomas M'Ilwraith, and suspicious movements of a German war vessel

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1887.—Daly, D. D. : Proc. Roy. Geog. Soc., pp. 1-24.

Brassey, Lord : "Nineteenth Century" for August, pp. 248-256.

1888.—Mayne, Admiral R. C. : Proc. Roy. Geog. Soc., pp. 134-146.

Abercromby, Hon. R. : "Seas and Skies in many Latitudes" (Stanford), pp. 302-350.

1889.—Brassey, Lady : "The Last Cruise of the *Sunbeam*."

The best and fullest source of information, however, is the *British North Borneo Herald*, an official monthly publication printed at Sandakan. The annual volume now current is the *eighth*.

\* The best compendium of the geography of the Malay Peninsula will be found in Keane, Prof. A. H. : "Eastern Geography" (Stanford).

were reported to him, he did not require to be urged to action. A message was sent to Thursday Island ; the magistrate there—a noted terror to black evil-doers—crossed over to New Guinea, and on the 4th of April, at Port Moresby, the British flag was hoisted as a sign that the country was taken possession of in the Queen's name. If we think for a moment that the population of Queensland was at that time about half that of Glasgow, and that this handful of people had a country of their own exceeding in area three times the extent of the whole German Empire, the sending of a police magistrate to annex all the lands lying in the latitude of New Guinea between the 141st and 155th degrees of east longitude, does seem to savour a little of the humorous. It was not the amusing side of the affair, however, which most attracted attention at home. There was almost everywhere more or less openly expressed sympathy with Queensland, and admiration for her audacity and pluck. It was recognised that she had but acted as the child of her mother: that Great Britain when she was little Britain had oftentimes done the like. The Home Government, all the same, viewed the act with dissatisfaction; the Secretary for the Colonies expressed to the Queensland authorities a confident belief that no foreign power contemplated interference in New Guinea, and the hoisting of the flag as a declaration of British sovereignty was in quite clear terms repudiated. Much ill-feeling and irritation arose in Australia in consequence. The colonists denied that they had been the victims of a scare, and, as was proved by the events of the year we have now come to, they were right.

If a descriptive name be wanted for this year, a very fitting one would be "the year of the *Scramble*." A brief abstract of the doings of Germany and Britain alone would serve to show the appropriateness of the name; but, as you know, Germany and Britain were not the only powers which took part in the rather undignified proceedings. Some of you may remember, indeed, that for a while newspaper readers had an annexation served them hot almost every morning to breakfast. Early in January, as the outcome of a game of correspondence between Prince Bismarck and our Foreign Office, the German flag was hoisted at Angra Pequena in South Africa; in June, Prince Bismarck, seeing his way clear, at length showed his hand, openly avowing that he had determined to afford the protection of the Empire to German traders, wherever settled, and to further the

attainment of their object, if they desired to take possession of ownerless territory ; in July a German gunboat pounced on the Togoland coast and the mouth of the Cameroons river ; in the same month, our Foreign Office having apparently wakened up, the British flag was hoisted at Ambas Bay in the Cameroons district ; in August, Germany annexed the south-west African coast, from the Orange river to the line of the 26th degree of south latitude ; in the same month, Britain annexed the country of the Oil Rivers ; in November, after tedious correspondence with Australia, British sovereignty was proclaimed over the south coast of New Guinea and the adjacent islands ; in December, to the absolute consternation of the Australian colonists, Germany annexed the north coast of New Guinea and the adjacent islands ; later in the month, the Natal Government hearing that a German trader had been negotiating treaties on the coast of Zululand, planted the Union Jack at the entrance of St. Lucia Bay ; and so the year went out.

It is quite impossible for me, without wearying you, to convey anything like an adequate idea of the causes and motives which led to these actions, the temper of those who took part in them, and the generally excited political atmosphere by which they were surrounded. If, however, you will call to mind that 1884 was the year of the defiant Boer incursions into Bechuanaland and Zululand ; the year of our troubles with Russia over the Afghan boundary ; the year of strained relations with France, because of her action in Madagascar and our action in Egypt ; the year of our ill-fated treaty with Portugal regarding the Congo ; and, above all, the year of Prince Bismarck's cordiality with France, you will be able to supply many missing links in the chain.

Matters of course came to a climax. In January of the new year, on account of German meddling in Pondoland—the last strip of coast country between Cape Colony and Natal,—the British flag was raised at the mouth of the St. John River ; about the same time British sovereignty was extended over the only remaining part of New Guinea ; and, again, about the same time, any hopes the German Government may have entertained of joining hands with the Boers were finally stamped out by Sir Charles Warren's action in the country between the Germans and the Boers. Prince Bismarck then lost his temper and complained publicly of Britain's hostility to his colonial schemes : nay, he even went so far as to threaten. The consequence, of course, was that English feeling

against Germany, which had been bad enough before, now became bitter. Notice had to be taken in the House of Commons of the German Chancellor's speech, and the English Prime Minister, in doing so, declared in firm but dignified language that "the friendship of no country in the world was necessary to England, nor ever had been." Fortunately a scapegoat was found in a missing despatch, in which, as Prince Bismarck affirmed, he had opened his heart to the English Government on the subject of German colonisation, and had requested Britain's good offices. The way for a reconciliation was thus opened up. Count Herbert Bismarck was sent across to London to negotiate, and the friction between the two countries was said to have come to an end.

If 1884 may be termed the year of the "Scramble," 1885 was the year of "settling up." The German annexation in south-west Africa was agreed to by England with as good a grace as possible, the whole coast between the Orange River on the south, and the Portuguese Boundary on the north becoming a German possession, with the small but important exception of the territory of Walfisch Bay. There only remained there and elsewhere the fixing of boundary lines, so that in future the clashing of interests might be, as far as possible, avoided. With this end in view, two agreements were come to between the two powers.

The first concerned the African acquisitions bordering on the Gulf of Guinea. The terms were :—

"Great Britain engages not to make acquisitions of territory, accept protectorates, or interfere with the extension of German influences in that part of the coast of the Gulf of Guinea, or in the interior districts to the east of the following line—that is, on the coast, the right river bank of the Rio del Rey entering the sea between 8° 42' and 8° 46' longitude east of Greenwich; in the interior, a line following the right river bank of the Rio del Rey from the said mouth to its source, then striking direct to the left river bank of the Old Calabar or Cross River, and terminating after crossing that river at the point about 9° 8' of longitude east of Greenwich, marked "Rapids" on the English Admiralty Chart. Germany engages not to make acquisitions, accept protectorates, or interfere with the extension of British influence in that part of the coast of the Gulf of Guinea lying between the right river bank of the mouth of the Rio del Rey, as above described, and the British Colony of Lagos; nor in the interior to the west of the line traced in the preceding paragraph. Both Powers agree to withdraw any protectorates already established within the limits thus assigned to the other, a reservation being specially made as to the settlement of

Victoria, Ambas Bay,\* which will continue to be a British possession. Germany engages to withdraw her protest against the hoisting of the British flag at Santa Lucia Bay, and to refrain from making acquisitions of territory or establishing protectorates on the coast between the Colony of Natal and Delagoa Bay."

No mention is made, you will observe, of a boundary line to separate German Togoland from the British Gold Coast on the one hand and from the British Niger districts on the other. Such lines must be laid down sooner or later. The difficulty of doing so in the latter case is much increased by the fact that a strip of intervening coast, 40 miles in length, is divided between the King of Dahomey, Portugal, and France. As for the administration of the great extent of territory thus definitively reserved to Britain, it need only be recalled that in 1886 a Royal Charter was granted to the representatives of the National African Company, which for some time previously had controlled the whole trade of the Lower Niger and Benue, and that, in virtue of this charter, the company, thenceforward called the Royal Niger Company, took over the entire management of a large portion of the territory in question.

The second agreement between England and Germany concerned New Guinea and the adjacent islands. The terms, in effect, were that the boundary between the possessions of the two countries should be a line starting from the coast in the neighbourhood of Mitre Rock on the 8th parallel of south latitude, and following this parallel to the point where it is cut by the 147th degree of east longitude, then proceeding in a north-westerly direction to the point where the 6th parallel of south latitude cuts the 144th degree of east longitude, and continuing in a W.N.W. direction to the point of intersection of the 5th parallel of south latitude with the 141st degree of east longitude. As the German share was to include the islands of the Bismarck Archipelago (New Britain, New Ireland, &c.), the two shares were practically the same as regards area. In the following year the line thus laid down was prolonged so as to be a line of demarcation, not merely between the actual possessions of the two countries, but between their spheres of influence in the Western Pacific. The prolongation may be roughly described by saying that it is drawn so as to leave Treasury Island, half of the Solomon Islands, and the Gilbert Islands on the British side, and so as to include within the German sphere the Marshall Islands and the other half of the

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\* Reservation afterwards withdrawn.

Solomon Islands.\* Saving as regards the Samoan group, the Tongan group, and Savage Island, which were expressly excluded from the agreement and designated as a neutral region, this article of demarcation should prevent all trouble between Germany and England in the Western Pacific for the future, and, by setting each nation its own duties, should hasten the time when the lands of this artificial division of the globe shall be accurately surveyed, and the fauna and flora fully described.†

Germany, however, was not the only state with which we settled up in 1885; there was also the Transvaal. Indeed, in point of time, the Transvaal settlement, as I hinted a little ago, came first. A few words will recall the sea of troubles into which we had got with the Boers. We had magnanimously or ignominiously given them back the government of their country, and in return we had got nothing but abuse and lawless disregard of our authority in native territories beyond their borders. Having broken the convention we had made with them, they had the assurance to send a deputation to London in the beginning of 1884 to get the convention modified to their taste. Even this, strange to say, was in part done; on one point, however, public opinion was too strong for them—we declined to give up our allies, the Bechuanas. Mistaking good-natured concessions for weakness, and encouraged by the action of Germany, they continued their high-handed courses. War was declared by them against the chief Montsioa; our authority was ostentatiously set at naught; armed bands terrorised the country; and an Englishman, who acted as agent of one of the chiefs, was brutally murdered. At last our Government saw that the Boers would require to be taught the simple lesson that treaties were not made to be broken,

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\* See Parliamentary Paper, "Western Pacific, No. 1" (1886), where the complete line of demarcation is indicated on a map, and the full text of the agreement given; or see *Nineteenth Century* for November, 1886, where, accompanying a paper on "Europe in the Pacific" by Mr. Kinloch Cooke, there appears a most instructive map showing not only the German-English line, but also the German-Spanish line and the line of the Western Pacific (15° N., 165° E., 30° S., 130° E.). The insertion of the line of the German-British neutral region and the names of a few more of the islands would have made this latter map nearly perfect.

† Germany at least has most faithfully entered upon this work. Her New Guinea Company, since its formation, has issued regularly the *Nachrichten von Kaiser Wilhelm's Land*, a publication which for its maps and other scientific information is a wonderful contrast to the *North Borneo Herald* referred to in footnote on page 8.

and a sum of three-quarters of a million was voted in November, 1884, to send out a military expedition under Sir Charles Warren. The Boers did not wait to fight; order was soon restored; treaties were made with the friendly chiefs; the outcome of all being that in January, 1885, a provisional protectorate was proclaimed over a territory as large as Spain, having for its west boundary the line of the 20th degree of east longitude, and for its northern boundary the line of the 22nd degree of south latitude.

The importance of this step can scarcely be exaggerated. It convinced both Boers and Germans that we were in earnest. As before remarked, it planted a barrier between the two, wide enough to put future intrigue out of the question; and, what some authorities viewed as most important of all, it gave to Britain full command of the trade route into the interior.

Although African annexation did not by any means come to an end with the close of the year 1885, we are obliged, on coming to 1886, to leave "the dark continent," and betake ourselves to the East. There troubles had begun during the course of the preceding year, or earlier. In Upper Burmah the system of government, as you know, had for years been bad; the murders and cruelties which attended it would alone have made it notorious. In 1885, however, a climax was reached, so far as our relations with it were concerned. A British trading company, which had concessions in the country, was most harshly and unjustly treated, its servants even being fired on by the king's troops, and could obtain no redress. It came to light, too, that the king had been coquetting with the French, and had been acting as stated partly through French influence. The Government of India was forced, most reluctantly, to step in; an ultimatum was sent, and finally, towards the end of the year, a military expedition. With ease the capital was taken and the king deposed, and, on the 1st of January, 1886, the country was annexed to the Indian Empire. Although Upper Burmah has considerable mineral wealth, vast forests of teak, and much valuable land suitable for tropical agriculture, perhaps its greatest importance to us lies in the fact that it borders on China, and that we have thus placed in our hands a trade route to the otherwise distant inland provinces of that populous empire.

Returning now to Africa, let us take up the story of our connections with Germany. When speaking of the "scramble" of

1884, I omitted to chronicle the doings of a certain Dr. Karl Peters, because the year 1885 had come in before the public came to know that he had been at work. Peters, it seems, had founded at Berlin, in April, 1884, a Society for German Colonisation, one of the objects of which was to acquire land suitable for the establishment of colonies. By this Society the founder and two other members were authorised to proceed to Usagara (a district of East Africa which Stanley had spoken of in glowing terms), and attempt, by purchase or otherwise, to get a footing in the country. On 4th November they reached Zanzibar, travelling as steerage passengers, and under assumed names. A week afterwards they went into the interior, and a month after that two of them were back again at the coast with a pocketful of treaties, concluded with native chiefs, and entitling the worthies to claim possession of extensive tracts of country. Leaving the others to keep the treaty-making agoing, Peters hurried back to Berlin, founded the German East African Company, ceded to it his treaty-rights, and obtained for it from the Emperor a *Schutzbrief*, or Letter of Protection. These and other such doings in East Africa, when they came to light, created quite a sensation in this country. The lands in question had long been looked upon here as being under the sovereignty of the Sultan of Zanzibar, who had been for a considerable number of years the friend and *protégé* of Britain. Doubtless the Sultan protested, but in August, 1885, a powerful German squadron made its appearance at Zanzibar to show, as a German paper said, the meaning of an Imperial *Schutzbrief*; and, immediately after, it was announced that the Sultan had given in, and consented to the conclusion of a commercial treaty with Germany and the demarcation of boundaries by an International Commission. What Britain did during all this to stand up for her friendly ally and for her own rights has never been made public; we only know that the commercial treaty in question was concluded on 20th December, 1885, and that, after about a year's negotiations, Britain and Germany signed a convention which practically was the death-warrant of the Sultanate of Zanzibar.

The exact terms need not be given. Suffice it to say (1) that the Zanzibar dominions were cut down to a mere strip, the full extent of coast line being indeed retained, but the breadth curtailed to ten miles throughout; and (2) that all else fell to Germany and Britain, the former obtaining by far the larger

share. The boundary line between the two European "spheres of influence" was fixed to run from the mouth of the Umbe in a straight line to Lake Jipe, along the east and north shores of the lake, across the river Lumi, dividing equally the districts of Taveta and Chaga, and then along the northern slope of the Kilimanjaro range, in a direct line to a point in 1° south latitude on the eastern shore of the Victoria Nyanza. To the south of this line, as far as the Rovuma, German influence was to prevail; to the north of it, as far as the Tana, British influence. Whether the Rovuma throughout its entire course was to be the southern boundary of the German sphere was not specified; the boundary of the Tana, however, was definitely described "as a line commencing from the mouth of the Tana river, following the course of this river or its tributaries to the intersection of the equator with the 38th degree of east longitude, and from thence continued straight to the intersection of the 1st degree of north latitude with the 37th degree of east longitude." No boundary in the interior was laid down for either sphere, so that the agreement could not be looked on as providing a final settlement of the East African question.

The only hypothesis one can venture to throw out as tending to explain Great Britain's participation in such a high-handed course of action is that she had come to recognise the fact that Prince Bismarck had quite made up his mind to provide German colonies at the expense of Zanzibar; and, either to please him, or because she could not help it, she assented, contenting herself with moderating his demands, so as to preserve for the Sultan a semblance of independence, and for herself a moiety of her former influence in the region.

The administration of this new British territory was provided for later. On the 24th May, 1887, an English Company obtained from the Sultan of Zanzibar a fifty years' concession of the strip of coast-land bordering the British sphere of influence. The moving spirit of the company was Mr. (now Sir) William Mackinnon, who, many years before, might have had ceded to him, on similar terms, not this portion alone, but the *whole* of the Zanzibar coast. The company soon developed into the powerful Imperial British East African Company, to which on 3rd September, 1888, a Royal Charter was granted, conferring upon it the management of all the lands within the British sphere of influence. Already it has made notable progress with its work. By judicious pro-

cedure, no friction with the natives arose out of the change of masters. Trade soon began to develop. Exploring caravans were sent out to open peaceable mercantile relations with the peoples of the interior. Plans were framed for improving the harbour of Mombasa, naturally one of the best on the East African coast. Surveys for railways were initiated, and the laying of a telegraphic cable from Mombasa to Zanzibar was proceeded with. In 1889, under the auspices of the company, an eight-sheet map of the territory was published, the title-page bearing the announcement—most significant to the members of a Geographical Society—that

“Travellers and others into whose hands this Map may fall are earnestly requested to forward corrections and materials for improving it. . . . If these corrections have been made upon the Map itself, a clean copy will be furnished, as long as copies are available, in exchange for the revised copy received. Itineraries and other notes will be conscientiously used in preparation of a new edition of this Map, to be issued in the course of next year.”

From all this it will be gathered that the new territory has fallen into the right hands, and that its future may be looked forward to with confidence.

We have only further to note, that during the progress of negotiations with Germany, Britain, in conformity with an old arrangement, annexed the island of Socotra—an additional safeguard of the road to India.

A quite unimportant annexation was also made in the Pacific, the British flag being hoisted on the Kermadec Islands, a little group lying on the route between New Zealand and Samoa.

Were it not for this last, the year 1886 deserves to be called “the year of spoliation.” “Might is right,” was the only law kept in view.

We come now to 1887. Sir Charles Warren’s action in 1885, it will be remembered, had brought the Boers to their senses, so far as disturbance on their western border was concerned. The question of their interference in Zululand, however, was left untouched; and, as a consequence, Zululand received from that time forward their undivided attention. By the London Convention of February, 1884, already referred to, the Boers had been granted the right of concluding treaties with the Orange Free State, and with native chiefs. This right, as might have been foreseen, they very soon exercised to the detriment of the

Zulus. No time was lost in forming an alliance with one faction to make war against another; by the month of June the Chief Usibepu was completely defeated; and by the month of August a Boer Republic was proclaimed in the conquered territory. The uninviting story of the two years following need not be given, more especially as the outcome of all was the formal recognition, by Britain, of almost every claim which the Boers made. In February, 1887, the limits of the new Republic were defined, and a British protectorate proclaimed over the remaining part of the country. Including the Reserve, which had previously been under our protection, the portion which thus fell to be governed by Britain was 8,220 square miles in extent. The new Republic obtained 2,854 square miles. With this partition of Zululand, the broils and troubles of its people, it is to be hoped, have ended. Our connection with them forms a distressful tale, the lessons of which will surely not be lost sight of in the future.

Another portion of Africa engaged the attention of our diplomatists in 1887—namely, the North Somali Coast. On account of its proximity to Aden, and by reason of the barrenness of the latter, this coast, for a considerable number of years, has had connection with British subjects by trade, and not a little influence had thereby been gained by the representatives of our Government over the affairs of its people. When Egypt evacuated the posts of Zeila and Berbera, in 1884, this influence took a quite definite shape, as she left the ports in our hands. In time we, in this way, became neighbours of the French, who, having considerable eastern trade through the Red Sea, had so long ago as 1862 purchased Obock, on the northern side of the Gulf of Tajurrah, and since then had extended their borders. To prevent future difficulties between the two nations, an agreement was come to in May, 1887, that a line from Cape Djiboujeh (Jibuti) to Harrar, and then west to Shoa, should separate their spheres of influence, Britain recognising the rights of France over the territory of Obock and the Gulf of Tajurrah, and ceding to France the Musha Islands, situated in the Gulf; and France, on her part, recognising the rights of Britain to the coast territories to the eastward as far as and including Dongarita. The British claim, however, now exceeds this, the protectorate being continued along the coast from Dongarita round Cape Guardafui to Cape Hafun, where the Italian protectorate begins. Further extension, unless in an inland direction, is thus impossible in this neighbourhood.

In the same year (1887) we rounded off our possessions in a similar manner in another quarter of the world—the Malay Peninsula. The absorption of the States of Perak, Selangore, and Sunjei Ujong in 1874 has been referred to, and we have chronicled the like fate of the Nēgri Sēmbilan in 1883. This left only two independent states in the Peninsula—namely, Johor and Pahang. The case of Johor was peculiar. By reason of its proximity to Singapore its rulers early came under British influence, and for many years before the date we have now reached, the most friendly relations existed between the present Sultan and our Government. He had visited England several times; western ideas of civilisation had gained a certain hold on him; and under the influence referred to he had introduced improvements into the administration of his state, which made it a pleasing contrast to its Malay neighbours. The change which took place in 1887 was thus more formal than real. In that year he practically accepted a protectorate by placing his relations with foreign countries under our care. A similar arrangement was about the same time made with the Rajah of Pahang—a state lying to the north of Johor, and having its sea border on the east side of the Peninsula. Although not so well known as its neighbour states, it has the reputation among the Malays of being the richest of all in minerals. As has just been said, after the absorption of Pahang there remain no more little worlds to conquer in the neighbourhood of the Malay Peninsula. British territory now borders on the kingdom of Siam; the kingdom of Siam borders on Annam and the other eastern possessions of France; and China lies to the north of all three. Unfortunately, Siam somewhat closely resembles the pipkin between the iron pots; but should it escape the fate of its analogue, Great Britain has clearly reached the end of her tether in this direction. It would be difficult to exaggerate the importance of the policy which has peaceably and almost without exertion led to this result. Before the adoption of the policy in 1874 by Sir Andrew Clarke, there was continual turmoil in the native states of the Peninsula. Since then the moral and material condition of the country has improved by leaps and bounds. The population has been increased by the influx of an immense number of hard-working Chinese; the mineral and vegetable resources of the land have been developed; and adequate protection for person and property has been provided. Of the material progress no more

conclusive proof can be given than the fact that the *local* trade of the Straits Settlements has grown to be considerably more than double the trade with the United Kingdom, although the latter has steadily increased. These results of the onward but inaggressive policy of 1874 must commend themselves to all ; to the British taxpayer they ought to be doubly attractive, because they have been bought without price, the protected states paying the expenses of our administration.

When we come to the year 1888, we find that the additions made to the empire were less the result of compulsion by immediate circumstances, and more the outcome of political foresight. Our rulers had evidently seen cause to reconsider the policy of the nation in regard to annexation, and a change had been resolved on, not very radical in character, but still in the direction of a mild activity.

After Eastern Zululand passed into British hands, there yet remained a portion of unclaimed sea-board territory separating it from the furthest south Portuguese possessions in the neighbourhood of Delagoa Bay. To this territory of Maputaland (or Amatongaland) some importance was to be attached, because certain authorities held that a railway into the Transvaal might be constructed from a point on its coast, and that such a railway would prove a powerful rival to the Portuguese railway from Lorenzo Marques. From a strategic point of view, also, it manifestly had considerable value : for in the hands of a European power hostile to Britain and friendly to the Transvaal, it could have been made to tell severely against British interests. It was doubtless in view of such facts that a treaty of friendship was concluded between the Governor of Natal and the Chief of the Maputas, whereby the so-called Amatongaland became practically included within the sphere of British influence. By this act the British South African coast was extended to its utmost possible limits—namely, from the Orange River on the west, right round to the vicinity of Delagoa Bay on the east,—Germany being our neighbour on the one hand and Portugal on the other.\*

A similar but more important treaty, so far as extent of territory was concerned, was concluded with Lobengula, the chief of the Matabeles. By it there was set apart for the future sovereignty

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\* See London Chamber of Commerce Journal, March, 1888.

of Britain the whole of Matabeleland, with tributary lands, inhabited by Mashonas, Makalakas, and other tribes—an immense territory (“Zambesia”), stretching from the Transvaal on the south to the Zambesi River on the north, and extending eastwards to the inland boundary of the Portuguese possessions. From a number of different points of view this step must be considered as one of the highest importance. It was the natural continuation of Sir Charles Warren’s action in 1885 in Bechuanaland, and made British territory widely continuous from Cape Town to the Zambesi. It helped to ensure that Britain should be the paramount South African power, and it gave her a strong lever in her contest with Portugal in regard to the open navigation of the great waterway claimed by the latter. Furthermore, the new territory in itself, and apart from its situation and surroundings, was a valuable acquisition. Its agricultural and mineral wealth are spoken of in glowing terms. More than one traveller has affirmed that its gold fields are the richest in South Africa, and there can be no doubt that it contains numerous healthy plateaus well suited for cultivation even by European settlers. Not long after the conclusion of the treaty (December, 1889), the administration of the country was placed by Royal Charter in the hands of a powerful and influential company—the British South African Company,—and already good progress has been made towards the development of its resources. A continuation of the Cape Town and Kimberley Railway, for example, has been begun under the company’s auspices, the intention being thus to form a grand trunk line northwards into the interior. On the whole, it may be safely affirmed that of all the four chartered companies formed during our ten-year period no one has so promising a future as the British South African Company, if it has the knowledge and power to use its opportunities aright.\*

In another part of the world the same process of gathering in our natural inheritance was being quietly carried on about the same time. The state of affairs in the large island of Borneo has been already referred to, when chronicling the acquisition of its north-eastern corner by the British North Borneo Company. It need only be recalled, therefore, that though by far the greater

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\* Selous, F. C., in *Proc. Roy. Geog. Soc.*, 1888, pp. 169, 352; 1883, p. 268; 1884, p. 284; 1888, p. 293.

Kerr, Montague: “*The Far Interior*,” 2 vols. (Sampson Low & Co.), 1886.

portion of the island had long been under the sovereignty of Holland, there still at that time existed two independent native states, Sarawak and Brunei. The latter, as we have seen, was moribund—an easy prey to its vigorous neighbours, British North Borneo on the east, and Sarawak on the west. How Sarawak came to be vigorous is well-known. Who has not heard or read the story of Rajah Brooke?—how, in 1839, he came in a vessel of his own to Sarawak, helped to put down anarchy in the country, and was rewarded with a Rajahdom 3000 square miles in area; how, unsupported from without, he ruled his State with wisdom and beneficence for more than a quarter of a century, and at his death left it increased in size and inhabited by a busy and loyal population, to be governed by his nephew and heir, the present Rajah. “Rajah Brooke,” says Alfred Russel Wallace, “had his reward in having brought peace and safety and plenty, where there was before war and oppression and famine, and in leaving behind him over the whole of northern Borneo a reputation for wisdom, for goodness, and for honour which will dignify the name of ‘Englishman’ for generations to come.” A quite recent visitor, Lord Brassey, testifies that the good work still goes on. He says, “The work accomplished at Kuching itself (the chief town) is but a light achievement in comparison with the establishment of a settled government over a region of 50,000 square miles. Throughout this wide tract, a population of 300,000 people has been diverted from head-hunting and marauding to peaceful pursuits. Mines of antimony have been opened. The produce of the jungle—india-rubber and gutta-percha, gum and sago—is now carefully collected. A valuable trade in timber has been established. Coffee and pepper are being increasingly cultivated. A regular steam communication has been established with Singapore and along the coast. Something more than these material improvements has been achieved. Education is being gradually diffused. The abolition of slavery among the natives is the last crowning act of the Rajah’s administration. Let it be remembered that all this has been carried out by two Englishmen, who, without the aid of their government, chivalrously went forth to make war on piracy, and who, having been accepted as their rulers by the people, have expended on their subjects, and not upon themselves, the entire revenues of the territory over which they rule. I have travelled much. Nowhere have I felt more proud of the great qualities of my countrymen than when I visited Kuching.”

Surely it would have been a thousand pities if a native state with a record like this had passed into the hands of any other European country than Britain. Fortunately, our Government realised its duty in the matter, and in September, 1888, agreements were made with the Rajahs of Sarawak and Borneo whereby the two states were placed under British protection. In the preceding May a similar agreement had been made in regard to British North Borneo. Thus there came to be but two sovereignties in the island of Borneo, British on the north and north-east, and Dutch on the west and south.\*

In still another quarter of the globe, the tropical Pacific, the work of formally widening the empire was cautiously proceeded with. For many years, as is well known, our countrymen, either as traders or missionaries, had exercised a wide-spread influence in the Pacific. Many of the coral or volcanic specks on that vast ocean were practically under British domination, and the chiefs of not a few had repeatedly asked to be placed under the protection of our flag. When, therefore, action was resolved on, partly in consequence of preparation to lay a telegraph cable connecting British Columbia and New Zealand, it was an easy matter to bring about the desired form of relationship. The first three islands to be proclaimed British were Fanning ( $3^{\circ} 51' N.$ ,  $159^{\circ} 21' W.$ ), Christmas ( $1^{\circ} 57' N.$ ,  $157^{\circ} 27' W.$ ), and Penrhyn ( $9^{\circ} S.$ ,  $158^{\circ} 3' W.$ ). Apart from their position as convenient stations on a north-and-south line in about longitude  $158^{\circ} W.$ , they are of little value, being but small atolls covered with cocoa-nut trees, and therefore having only one vegetable product to export—namely, copra. Christmas, the largest of them, 90 miles in circumference, has little even of this, being low, barren, and unsupplied with fresh water. The most interesting anthropologically is Penrhyn, being the easternmost island in the Pacific inhabited by Melanesians,† of whom it supports 300. Fanning has deposits of guano, and from the other two a small amount of mother-of-pearl is exported.‡ About seven months later (October and November), a much more valuable acquisition was made further south, but in approximately the same longitude—the Cook or Hervey Islands, an extensive group lying between

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\* *British North Borneo Herald*, August, 1889.

† *Journ. Anthropolog. Inst.*, VI., p. 231.

‡ Papers relating to the Pacific Ocean (*Australian*, No. 138), 1889, pp. 50-55.

the Society Islands (belonging to the French), and the independent Friendly Islands. The group consists of half-a-score or more scattered islands of various sizes, harbourless, but fertile and beautiful, the most important being Raratonga, 530 miles in circumference, which is accessible on its north side by two small openings in the reef, and which has thus become the centre of foreign trade. They have long been a preserve of the London Missionary Society, and consequently the people are well advanced in civilisation. The present number of inhabitants is probably under 10,000, and, unfortunately, it is rapidly diminishing.\*

It only remains to note, for the year 1888, that also in the Indian Ocean a small island was annexed, bearing the same name as one annexed in the Pacific—Christmas Island. The two islands resemble each other in their solitariness, the Christmas of the Indian Ocean having for its two nearest neighbours, Java, 200 miles to the north, and the Cocos-Keeling Islands, 700 miles to the west. In outward appearance they are very unlike, the one, as we have just seen, being a low-lying barren atoll, while the other is a lofty precipitous island clad from base to summit with trees and jungle undergrowth. In the event of the laying of a direct telegraph cable from India to Australia, the second Christmas Island may prove useful. It is at present uninhabited.†

In 1889 the work begun the previous year in the Pacific was continued, one island or island-group after another being added until little was left. The locality of these transactions may be best described by saying that if a point a few miles south of the equator, in west longitude 161°, be taken, and a circle of 1,000 miles radius be described on the surface of the Pacific, the circumference will include all the additions referred to. Not only so, but there will be included three of the islands annexed in 1888—Fanning, Christmas, and Penrhyn; and, what is most noteworthy, the flag of no other European nation flies on land within the circle! As has been said, however, the islands are but coral specks on the waste of waters, the area of them all being but a few hundred square miles. Beginning north of the equator and circling round, we have in order Palmyra, Washington, Fanning, Christmas, Jarvis, Penrhyn, Humphrey, Rierson, the

\* Papers relating to the Pacific Ocean (Australian, No. 138), 1889, pp. 48-50.

† See account by Captain Wharton, Hydrographer to the Admiralty, in Proc. Roy. Geog. Soc., 1888, pp. 613-624.

Suwarrow Group, the Union Group, and the Phoenix Group.\* Palmyra is an example of an unfinished coral island, consisting, at present, "of fifty-eight small islets, thickly clothed with vegetation, and arranged in the form of an elongated horse-shoe, open to the westward, and enclosing four lagoons." Washington is equally remarkable as an obliterated atoll, the usual salt-water lagoon having given place to a fresh-water lake. These two, with Fanning and Christmas, are the only islands in the circle which lie in north latitude. Jarvis is almost on the equator, but south of it. Humphrey or Manihiki, about thirty miles in circumference, and having a deposit of good pearl shell in its lagoons, is mainly interesting on account of its inhabitants, who dress like Europeans, are well-disposed, highly intelligent, skilful in mechanical arts, and in many cases able to read and write English. Rierson or Rakahanga, a near neighbour to Humphrey Island, is about twenty miles in circumference, and is equally conspicuous for the high civilisation of its people. The Suwarrow Islands ( $13^{\circ} 13' \text{ S.}, 163^{\circ} 9' \text{ W.}$ ), three in number, but often spoken of as one, are the furthest south within the circle. The Union or Tokelau Group, consisting of three clusters of islets, is inhabited by a people closely resembling the Samoans, whose group is directly to the south. The Phoenix Group, north of the former, is more scattered, and comprises eight islands in all.†

It is not easy to give a very definite idea of the immense extent of territory brought under the sway of Britain by these annexations and treaties of the past ten years. In a number of cases the area is known with considerable accuracy; in others, where the inland boundary is indefinite, such as the Niger district and the territory of the Imperial British East African Company, only a rough approximation to the area is possible. Even, however, with a

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\* The most reliable information in regard to these and other Pacific islands is to be found in the Admiralty Sailing Directions (Pacific); but see also Findlay's Pacific Directories; Trendell's "Colonial Year Book" (1890); "Colonial Office List" (1890); Cooper's "Coral Lands" (1882); Moss's "Through Atolls and Islands in the Great South Sea" (1889).

† It is worth observing, further, that there are several other islands within the circle which are to all intents and purposes British. These are Malden, Caroline, Flint, Starbuck, and Vostok. The Government granted to a Melbourne firm, on 1st January, 1888, a seven years' license to export guano from Malden; to another trader, on 29th November, 1885, a license to plant cocoa-nut and other trees on Caroline and Flint; and similar guano licenses in respect of Starbuck and Vostok have expired.

low estimate in the latter cases, there is obtained, on adding up, the enormous total of 1,250,000 square miles. The meaning of this will be better grasped when it is stated that England, Scotland, Ireland, Denmark, Holland, Belgium, France, Switzerland, Spain, Portugal, Italy, Greece, Austria-Hungary, and Germany, all put together, do not reach it. The present population, too, taken over the whole area, is anything but dense—very probably not more than 12 persons to the square mile. So that if it were increased by an immigration of 40,000,000 (which is an over-estimate for the present population of the British Isles), the density would even then be only 44 persons to the square mile; that is to say, there would be enough land to give  $14\frac{1}{2}$  acres to each man, woman, and child of the whole mixed population, British and native—an acreage, be it noted, considerably in excess of the requirements of the land-law reformers.

The figures are rather startling when it is remembered that they represent the additions to the Empire during a single decade; and one cannot pass them by without inquiring what it was in the national character or circumstances that brought about such a result. There can be no doubt that in some instances the cause was an old and familiar one—the *push, enterprise, and energy of British merchants*. Not, of course, that merchants directly or consciously work for territorial expansion; but the purely business relations which they initiate and develop tend to grow into relations that are political. Equally clear is it that in other cases the cause was also one which had often before come into play—the *proximity of a well-governed state to a badly-governed state*; than this, no cause is more effective. Once allow a vigorous civilised power to plant a settlement in a savage or partially-civilised country, and expansion of the settlement is inevitable; it is almost inevitable even if the desire to expand be awanting.

So well recognised had these two causes become to the British Parliament, that for some years prior to our period they had not been allowed to have full effect. Annexations were discountenanced, and territory already annexed was given up. Repeated applications for protectorates were received, and firmly refused. So openly, too, was all this done that on the Continent the decay of Britain was complacently discussed: the mother of nations, it was said, had become old and was aweary. It only required, however, the overbearing interference of a rival, and the imposition of tariffs aimed at British commerce, to rouse the national

spirit and to call forth all the wonted vigour. And herein lies the third and greatest cause of all for our action. *We were driven to annex* because of the doings of other European powers, whose aims were anything but friendly to us and to our commerce. The procedure of our Government stood out in marked contrast to that of Germany, for example: our motto, unlike hers, being "Defence, not Defiance." No one could question the right of Germany to found colonies; her emigrants have been eminently successful in all quarters of the world, and nowhere more than under the protection of the British flag. What surprised and irritated us as a people was her method of setting about it, and the uniform respect paid by her to the claims of every European nation save and except Britain alone. France, her hereditary enemy, whose dependencies in Africa are most extensive, she never once came into contact with: Britain, her hereditary ally, who, by the voluntary confession of her own merchants, had often befriended them in their ventures, was the subject of repeated annoyance.

Another indirect and quite unintentional cause of the expansion of the empire has been *the labours of British missionaries*. This is notably the case in regard to the Pacific Islands and Africa; and in pointing out the fact it is but right that credit be given to the missionaries in those parts of the world for the success which has attended their labours. Among travellers and geographers opinion has been divided as to the value of missionary effort, and the question has oftentimes been raised whether the churches were wise in their selection of methods for Christianising the heathen world. I am free to confess that I think the question is still partially an open one. I do not think, however, that any fair-minded man, with the necessary evidence before him, will deny that missionary work in the Pacific has been marvellously powerful for good. One only wishes that as much could be said for the influence of the traders. The case of South Africa, as a whole, is not quite analogous; but in regard to part of it, Bechuanaland, the same testimony can be borne. In proof of this, and to emphasise a contrast before referred to, let me quote a few words by an able South African official:—

"This," he says (meaning the spontaneous offer of Bechuanaland to Britain), "was not obtained by the hurried march of a traveller with a flag in his hand, but was the result of patient and friendly intercourse between British subjects and Bechuanaland for two generations. The country was first described by Englishmen. Its

waggon-roads were made by Englishmen's waggons. Livingstone's was the first road to Lake Ngami and the Zambesi; Moffat's was the first, and is still the only fully opened road to the Matabele."

. . . "I shall not enlarge," he continues, "upon the value or the success of the teaching of Moffat, Livingstone, and their successors. What I wish to bring before your notice is the remarkable fact that these men, themselves totally unconnected with the English Government, so lived and so taught in Bechuana-land that the natives, chiefs, and people formally preferred the request that their country might come under the permanent control and government of the Queen."

Facts like these cannot fail to call up before us the great responsibility placed on us as a people by having brought more or less directly under our sway the inhabitants of these million and a quarter square miles. It ill becomes us to speak lightly, as is often done, of the possible transference of territory from the hands of the indigenous inhabitants to those of our adventurous and sometimes unscrupulous countrymen. With the history of past efforts in colonisation before our minds, it must surely be the heartfelt wish of all that the new lands shall be governed for the welfare, material and moral, of the peoples who at present hold them. That this is no impossibility is conclusively proved by the story, which once more may be commended, of Rajah Brooke and Sarawak. Happily, in a country like ours, a benevolent wish of this kind need not be only a wish. Through the press and otherwise the legislature can be reminded and can be influenced to take care, amid its multifarious duties, that annexation shall not mean gratification of political ambition, or the satisfaction of commercial greed, but prosperity and a well-ordered government to the natives, and, when they are ripe for it, the other blessings of a true civilisation.

*P.S.*—Since the foregoing was written further acquisitions have been made. The Imperial British East African Company has obtained a concession of the remaining Zanzibar ports to the north of the original German and British spheres of influence, and a protectorate has been proclaimed over a considerable tract of country traversed by the Shiré River. The latter is doubtless but the beginning of extensive operations in the region of the African Lakes Company. What exactly has been accomplished need not be stated, as the present boundaries cannot possibly be final, Great Britain, Portugal, and Germany being engaged in negotiations on the subject.

X.—*Note on the Alteration of the Index of Refraction of Water with Temperature.* By MR. GEORGE E. ALLAN, Physical Laboratory, Anderson's College.

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[Read before the Society, 5th February, 1890.]

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THIS experiment was undertaken for the purpose of finding how the refractive index of water alters with the temperature. The indices were calculated from the well-known formula,  $\mu = \frac{\sin \frac{1}{2} (D + i)}{\sin \frac{1}{2} i}$ , where  $D$  is the minimum deviation of the ray of light after passing through the prism, and  $i$  is the angle of the prism.

The angle of the prism was determined by the usual optical method, and its value was found to be  $59^{\circ} 42'$ . The prism was filled with water, and the deviations for the different temperatures observed. These readings varied from  $23^{\circ} 31'$  at  $5^{\circ}$  C. to  $22^{\circ} 41'$  at  $80^{\circ}$ .

In order to heat the water an electric current was passed through a platinum wire coiled inside the prism. The water was heated to  $80^{\circ}$  and the readings were taken as it cooled. The image of the slit was indistinct unless the water had the same temperature throughout. To equalise its temperature the water was heated above the desired point, and then the prism was shaken so as to thoroughly mix the water. The position of the prism was marked, and the electric communication was made by mercury cups, so that the prism could be lifted up, shaken, and replaced.

To find the deviation for temperatures below that of the room—which was about  $15^{\circ}$  C.,—small pieces of ice were put into the prism and the water shaken up with them until the desired temperature was reached.

An iron wire was first used inside the prism, but it soon rusted, and when the prism was shaken the water became turbid. This difficulty was overcome by using a platinum wire.

The spectrometer read to half-a-minute, and a difference of half-a-minute in the deviation made a difference of .00011 in the index of refraction. A curve was drawn in which the abscissæ represented temperatures and the ordinates the corresponding indices of refraction. A table was also compiled giving the indices of refraction from 5° to 80°. These are as follow:—

° C.		Index.	° C.		Index.
5	...	1·33412	45	...	1·33019
10	...	1·33390	50	...	1·32941
15	...	1·33358	55	...	1·32836
20	...	1·33318	60	...	1·32753
25	...	1·33270	65	...	1·32639
30	...	1·33212	70	...	1·32542
35	...	1·33146	75	...	1·32437
40	...	1·33084	80	...	1·32316

XI.—*On Horticulture, Villa Gardening, and Open Spaces in Large Centres of Industry.* By D. M'LELLAN, Superintendent of Public Parks, Glasgow.

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[Paper read before the Architectural Section, 17th February, 1890.]

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HORTICULTURE, I need hardly say, is "the art of cultivating gardens." I do not intend tracing its progress down through the ages, but merely to note a few important facts connected with the principal gardens of ancient and modern times. The earliest instance we have in the world's history is the Garden of Eden. Bacon, the great philosopher, refers to it thus—"God Almighty first planted a garden, and indeed it is the purest of human pleasures." This sentiment we find expressed from the earliest times. Nations may differ in their method of laying out gardens. This depends to a considerable extent on the climate and surroundings; but nature has always been cherished and loved, and continues to retain a strong claim on the affections of mankind.

Among the oldest gardens are those of the Egyptians. We learn from ancient sculptures that they were of considerable extent, watered from the river Nile, and interspersed with canals and groves. Three thousand years have passed since their existence, yet it is interesting to note how similar was the taste for plants and flowers at that remote stage of history.

The gardens of Assyria were on a stupendous scale. The famous hanging gardens of Babylon rank as one of the wonders of the ancient world. These were square in form, each side being 400 feet in length, so that the area of the base was about four acres. They were built up in terraces to a height overtopping the walls of the city, which were 300 feet high. The various terraces were supported on walls 22 feet thick, with flights of steps leading from one to the other. At the bottom of the garden flowed a tributary of the river Euphrates, from which the water was pumped up to the highest terrace, so that there was no lack of water for the plants and fountains.

From the days of Noah downwards, the inhabitants of Palestine planted and reared vineyards and gardens both for profit and pleasure. Solomon made his garden a life study. He speaks of trees, "from the cedar that is on Lebanon to the hyssop that springeth from the wall;" and again, "I made me gardens and paradises," where were cultivated all sorts of fruits and flowers. His vineyard at Baal Hannon was let out for 1,000 pieces of silver per annum, equal to about £200 sterling of our money. The gardens of Palestine were mostly enclosures in the suburbs of towns, among the most famous being the garden of Gethsemane. In later days Damascus has been celebrated for its roses.

Among the Greeks and Romans gardening did not receive the same attention as architecture; still, with the increase of wealth, they attached handsome pleasure grounds to their villas. As a rule, these were not very extensive, but laid out regardless of expense.

With the decline of the Roman Empire civilisation received a severe check, and there was too much fighting to think of the gentle pursuits. The art of gardening was revived, however, to a considerable extent by the monks, and the celebrated Medici family did much to foster horticulture in the middle ages. The Italians can boast of being the first to establish gardens for purely scientific purposes. Another nation which has paid considerable attention to gardening is the Dutch, whose tastes are somewhat peculiar, as they delight in prim, symmetrical designs, clipped hedges, and dwarf trees. They are known as the most famous growers of bulbs in the world, the prices paid for some of which have been fabulous, approaching a perfect mania.

The gardening of the French School is also geometrical in respect of the designs employed. During the reign of Louis XIV. the gardens of Versailles were laid out by Andre le Notre on a most magnificent scale. A visitor once described them as a "foretaste of paradise." The fountains, which require £3,000 to provide a full display, are certainly without equal. No city in the world possesses such beautiful parks and gardens as Paris, and I daresay they are familiar to most of us present.

Turning now to our own country, we find the same love of the beautiful in nature equally strong amongst ourselves. The first attempt at horticulture in Britain seems to have been made by the Romans, though on a very limited scale. We hear of little being done again until the reign of Henry VIII., when Hampton Court was laid out. The maze in it occupies only a quarter of an

acre, and contains half-a-mile of winding walks. Chatsworth, another famous garden, was formed in the reign of Charles II., also the parks of Greenwich and St. James' by the famous Le Notre. The first great designer of English landscape-gardening was Kent. He was the father of our modern school, which tries to improve and not to distort nature. As time went on the tastes and habits of our nation became more and more refined. Gardens and pleasure grounds advanced in extent in the same ratio as the cultural art. To enumerate even briefly the lovely places scattered all over our country would be impossible in this paper. Their number is simply legion. It is within the last fifty years, however, that we find the greatest progress in horticulture; like everything else, it has made enormous strides in that period. For instance, plants and flowers used rarely to be seen in houses, except those of the wealthy, and then only to a limited extent. Now they are familiar in the houses of all classes, and at every season of the year. Even twenty years ago in our own city the only places where flowers could be purchased were at one or two shops, and at the principal nurseries. Now, owing to the improved mode of culture, keen competition, and increased facilities for bringing the articles to market by rail and parcel post, the most beautiful plants, flowers, and fruits that can be produced are to be bought at a very moderate figure in shops all over the town, and are often hawked about the streets in carts and barrows.

This improvement has been fostered, I venture to say, by the numerous flower-shows held all over the country, and by the great attention paid to plants and flowers in public parks and gardens. Fashions change in flowers as well as in articles of attire. Twenty years ago double flowers, such as dahlias, camellias, &c., were all the rage, while at the present time these have gone out of fashion, and single flowers are the favourites. This shows a tendency to return to nature, it being a well-known fact that all double flowers are monstrosities, and never reproduce their kind by seed. The demand for fruit has also developed in an extraordinary manner. Many kinds formerly known only by name and as luxuries to the generality of people—such, for example, as bananas, melons, pine-apples, custard apples, mangoes, &c.—are now obtainable at a moderate figure. Our venerable statesman, Mr. Gladstone, has recommended fruit-growing to the attention of agriculturists, which no doubt will lead to increased energy in this direction.

A humble but interesting branch of horticulture is window

gardening. We find it amongst all classes of the community, but more especially amongst the poor—often amidst the most squalid surroundings, and in an atmosphere so polluted with smoke that it is a marvel how plants can live at all. All honour to the Kyrle and other societies which seek to encourage this love for the beautiful. The men, women, or children who can care for and cherish their window oases must surely have a certain refinement which, with proper help and guidance, will develop their nature and lift them to a higher moral and spiritual plane.

Passing on to the next part of my subject, “Villa Gardening,” I shall endeavour to put before you a few useful remarks concerning it. A poet once wrote, “God made the country, man made the town,” and so we find that men instinctively gravitate to the works of nature, which are the works of God. There may be a passing pleasure in the sights and pursuits of the town, but for real relaxation we turn to the fresh air and green fields. In modern times improved locomotion has been the means of bringing town and country into much closer contact. Nowadays the merchant can live ten, twenty, or even thirty miles outside of the town and still be in immediate touch with his business. The benefits derived from this semi-rural mode of life are incalculable to the hard-wrought citizen.

When settling on a locality, the first consideration is *convenient access to the town by road or rail*. There are also other details not to be overlooked, such as the healthiness of the district, general surroundings, marketing facilities, &c. I have no doubt that most people do the best they can according to circumstances, but by making a wise selection at first a great amount of trouble and expense is avoided afterwards.

*The site of the house* is of the utmost importance, and should be carefully considered in connection with the disposal of the grounds. The architect and landscape-gardener should, properly speaking, work in unison, but too often the latter is sadly handicapped in his efforts to beautify the surrounding grounds by the situation of the house itself. The general amenity of a property is frequently spoiled by placing a house in the centre of a piece of ground or upon the most exposed part of it without regard to landscape effect. The situation ought to be towards the one end or side of the ground, leaving sufficient space in rear for kitchen garden and domestic offices, thus giving a larger area in front for the formation of flower gardens, ornamental water, or shrubbery.

*Conservatories* are usually placed at the side of a house, attached to drawing-room or parlour by an ante-room or passage, and often prove an acquisition to the architecture. The interior may be arranged with a shelf or border for plants all round, leaving a large floor space for tables on which choice plants are grouped, while the roof may be festooned with ornamental climbing plants and hanging baskets.

*Greenhouses and houses for forcing* should be detached from the dwelling-house. They may be placed in the kitchen garden or near domestic offices, where they would prove both ornamental and the useful. They act as feeders to the conservatory, and are invaluable for keeping up a regular supply of plants and flowers.

*Laying out of grounds.*—The first consideration in this matter is the drainage of both house and grounds, but it is only upon the latter that I will offer a few suggestions. In cases where the soil is stiff and retentive, drains of  $2\frac{1}{2}$ -inch tiles should be put in  $3\frac{1}{2}$  feet deep, and placed 18 to 24 feet apart. The soil should be turned over or loosened to a depth of 1 foot 6 inches, and all stones taken out and used in the formation of roads and walks. These should be made with great care in a most substantial manner, as often they are constructed very superficially, without any provision being made for surface drainage. Drains should be laid along the centre, with cross drains every forty or fifty yards, and having cesspools and gratings to receive the surface water. They should then be bottomed with stones hand-set—in the case of roads 9 inches deep and of walks 6 inches,—well broken, and blended with engine ashes or gravel. The position of walks should be carefully studied, both for convenience and effect, avoiding the cutting up of your ground too much with them, as they are both expensive to make and to keep in repair.

*The planting and arrangement of trees and shrubs* together form one of the most important operations connected with villa gardening. The most suitable kinds should be selected and grouped together for permanent effect, along with what are termed “nurses” of fast-growing sorts, such as willows, poplars, elders, &c., for immediate effect; these latter to be gradually removed as the others grow up. This massing of allied sorts of trees and shrubs may be carried out round the boundary of a property, in some cases for shelter from prevailing winds, or to secure seclusion from the public gaze. What is termed “dotting,” or planting promiscuously all over a space, should be carefully avoided, as it gives

the ground a contracted appearance, whereas nothing is more pleasing to the eye than a noble sweep of green sward interspersed with groups of ornamental trees and shrubs. (A list of the trees best adapted for the purposes which I have mentioned is subjoined.)

*The flower garden* should be situated near the house, either upon grass terraces or upon a formal grass plot, and should consist of perfect figures, ovals, circles, or squares, the furnishing of which with flowers is a matter of individual taste. In a villa ground of several acres a paddock for sheep or cows may add very much to the landscape and interest, and if out of sight of sea or loch an artificial lake with waterfowl is an undoubted attraction. Rockeries are sometimes fancied, and grottoes, waterfalls, and arbours, with Alpine plants, may be introduced with effect. As a rule, these should be placed in a background, where they are interesting and not obtrusive.

*Town or allotment gardens*, as they are called, are a great source of pleasure and, I may say, profit to the artisan class who cannot afford to live in the country. These gardens are divided off into plots of from 100 to 200 square yards, and let at a moderate rent per annum. Those who are fond of cultivating their own vegetables and flowers may here spend their evenings in tending their favourites, which will taste all the better and smell all the sweeter from being the outcome of their own industry and perseverance. Owners of land in the neighbourhood of crowded centres should encourage this industry as far as possible by letting their ground at a nominal rent, and thus afford rational enjoyment and healthful recreation to hundreds of their fellow-subjects.

In the United States and Canada, which I had the privilege of visiting several years ago, I noted that villa gardens differ very considerably from our own in one important respect. Instead of the property being enclosed, be it half an acre or several acres, with a hard-and-fast line of stone wall, there is nothing visible to indicate the boundary but a brief line of planting. There is no fence even along the public street. This is specially the case in the outskirts of such cities as Washington, Philadelphia, Toronto, and Cincinnati. There one may walk or drive for miles without seeing walls, iron railings, or gates, and yet property to all appearances is respected and protected. At home we still believe that "every man's house is his castle," and must be guarded accordingly, and perhaps in the present state of society it is just as well.

In drawing your attention for a few minutes to the third part of my subject, namely, "Open spaces in large centres of industry," I shall endeavour as far as possible to make my remarks of a practical nature. The importance of open spaces in large cities, both from a social and a sanitary point of view, is now generally admitted by all medical authorities. The late Mr. Loudon, the most eminent horticulturist that this century has seen, expressed himself with much earnestness of purpose upon this subject many years ago in the *Gardeners' Magazine*. He says—"In the public park the pale mechanic and the exhausted factory operative might inhale the freshening breeze and some portion of recovered health. The busy shopkeeper and the more speculative merchant might enjoy relaxation and bracing exercise in temporary seclusion from their toils and cares. The children with their nurses might take their walk or spend their playtime apart from the bustle of the streets, and secure from the accidents to which, in crowded thoroughfares, they are necessarily exposed. Without doubt, it is also good for the mental health of those who are habituated to the wear and tear of the busy haunts of men to be brought face to face with the tranquillising, as well as suggestive works of God in the works of nature." That is, as we must all admit, as true to-day as it was sixty years ago.

Having had the honour of superintending the public parks of this city for the last thirty-five years, and having made this and the minor spaces my special study during that period, the few observations that I propose making will be upon the size, situation, and general arrangement of these open spaces, with a few hints as to street and allotment gardens.

The size may be from one to forty acres, according to situation and other circumstances, and the public would derive greater benefit from several of that size in close proximity to their dwellings than one large one at a distance. These open spaces should be in such a position as to be of easy access to the inhabitants, where they would form breathing spaces or "lungs," and prevent that unhealthy crowding of streets and lanes so common in many large manufacturing towns. As a general rule, the best situation is on the windward side of public works, so as to ensure as pure air as possible; and if the ground be of an undulating character it will afford easy gradients for drives, walks, and drainage. All operations connected with these should be done in the most perfect manner, with provision for surface drainage. In a park of forty to

fifty acres a drive all round would afford pleasure to invalids and those who can afford their carriage, and would at the same time give a character to the place. It should partake mostly of pleasure grounds, in the way of lawns for walking over, shrubberies, flower gardens, and groups of suitable ornamental trees, which should be massed principally round the margin, leaving a large open space for recreation; and there should also be broad, well-kept walks, with seats, drinking fountains, and arbours to shelter from sun and rain. If at all practicable, a few acres devoted to artificial lakes with islands, cascades, rockeries, and waterfowl, lend a charm to the landscape, and form a source of pleasure to the general public, especially the young. A few enclosures for the pasturage of sheep during the summer months give also a glimpse of rural life to the citizens. Football and cricket should be strictly prohibited in parks of limited extent, unless in some quiet corner where there is no thoroughfare. A gymnasium, under proper control, might be added with advantage. The buildings necessary to a public park are limited to, say, a house for the superintendent, with tool and greenhouses at no great distance, and possibly a gatehouse for the ranger.

*Street squares* are allied in some respects to public parks. These open spaces, however humble they may seem, are very beneficial to the population around them, and they ought therefore to be more carefully considered by proprietors and builders when about to erect new blocks or terraces of houses. I consider that it is short-sighted policy on their part to cover the whole area of their property with narrow streets and tall houses, instead of allocating a few open spaces in the way of squares, or planning to have wide streets with a strip of grass or shrubs either in the centre or in front of the houses. I am convinced that the increase of their rents would more than compensate them for the apparent loss they may have sustained in laying out such grounds. In connection with this subject, I would desire to urge upon the sanitary authorities and those in power the importance of providing open spaces with seats and shelters in all congested quarters, where both old and young could have an opportunity of breathing the fresh air, and where the children could play free from the dangers of the streets.

*Private squares* and *disused burying-grounds* might be opened up to the public with great advantage under certain restrictions, such as keeping upon the walks, and protecting the trees, flowers,

and shrubs. A slight guardfence round the walks would be sufficient for this purpose. A very good beginning has been made in this respect in our own city by the throwing open of several squares and churchyards, and planting the same with shrubs and flowers. George Square is a notable example of the utilisation of an open space in the centre of the city, and it is greatly appreciated by the citizens. I understand that in London and many large towns the authorities are following much on the same lines, especially as to the burying-grounds.

Last, but not least in importance, in connection with these parks and open spaces is the providing of music for the people. Glasgow led the van many years ago by giving band performances in all the parks several evenings a week during the summer months. This boon has been extended lately to the public squares with much acceptance, to judge from the large and increasing audiences at the performances. The growing interest taken by the public in these efforts of the authorities to provide them with such elevating amusement has fully justified the expense incurred in this direction. I offer the suggestion that the authorities should go a step further, and erect in all the public parks winter gardens, where concerts and other amusements could be given from time to time amidst the agreeable surroundings of beautiful plants and flowers; at the same time these gardens would form a pleasant promenade and shelter in inclement weather.

I annex lists of the most suitable trees and shrubs for both villa and town gardens:—

LIST OF TREES AND SHRUBS FOR VILLA GARDENING WITHIN A RADIUS OF,  
SAY, SIX TO TEN MILES OF LARGE CENTRES OR CITIES.

Elm	Trees,	sorts.	Poplar,	balsalm.
Plane	„	„	„	aspen.
Maple	„	„	„	silvery.
Lime	„	„	Willow,	Huntingdon.
Service	„	„	„	red or sea-side.
Wild Cherry.			„	golden
Double	„		Ash,	common.
Beech,	common.		„	lenticifolia.
„	purple.		Alder,	sorts.
„	fern-leaved.		Chestnut,	common.
Poplar,	Canadensis nova.		„	red-flowered.
Poplar,	Ontario.		Acacia	Thorn.
„	Lombardy.		Sumach	or Stag-horn.

Flowering Thorns,	sorts.	Caragana arborescens.	
Laburnums,	„	Azalea,	sorts.
Oaks,	„	Rhododendrons,	sorts.
Syringa,	„	Erica,	„
Osmanthus ilicifolius.		Aucuba Japonica.	
Ribes,	sorts.	Laurus ovifolium.	
Spiræa,	„	„ colchica.	
Euonymus,	„	Hollies,	sorts.
Berberis,	„	Box Tree,	„
Viburnum,	„	Privet,	„
Garrya elliptica.		Cupressus,	„
Weigelia rosea.		Juniperus,	„
Forsythia fortunei.		Retinospora,	„
Potentilla fruticosa.		Yews,	„
Buddlea globosa.		Thuja,	„
Sea Buckthorn.		Thujopsis,	„
Elder of sorts.		Pernettya,	„
Leycesteria formosa.		Daphne,	„

LIST OF SUITABLE TREES AND SHRUBS FOR TOWN GARDENING.

Willow, red or sea-side.		<i>Evergreens.</i>	
„ Capria.		Rhododendron, Cunninghamii.	
„ Huntingdon.		„ Empress Eugenie.	
„ Bedfordiana.		„ Cataubiense and its var.	
Poplar, Canadensis nova.		„ ferrugineum.	
„ balsalm.		„ hirsutum.	
„ silver.		Cotoneaster Simonsii.	
„ Ontario.		Aucuba Japonica.	
„ aspen.		Holly Hodgensis.	
Laburnum, English and Scotch.		„ Maderiense.	
Flowering Thorns, of sorts.		„ nobilis.	
„ Elms, „		„ laurifolium.	
„ Service Trees, „		Osmanthus ilicifolius.	
Ash, common.		Laurel, colchica.	
„ flowering.		„ ovifolium.	
„ lenticifolia.		Privet, „	
Bird Cherry.		Thujopsis borealis.	
Double-flowering Cherry.		Azalea pontica.	
Sumach or Stag-horn.		Retinospora,	sorts.
Alder, of sorts.		Salisburia adiantifolia.	
Lilac, „		Garrya elliptica.	
Weigelia, „		Jasminum nudiflorum.	
Elder, „		Skimmia Japonica.	
Berberis, „		Vinca,	sorts.
Ribes, „		Euonymus,	„
		Daphne mezereum.	
		Potentilla fruticosa.	

*XII.—Notes on the Hydrostatic Arrangements in the Horse's Foot.*

By T. F. MACDONALD, M.B.

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[Read before the Society, 19th February, 1890.]

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(WITH PLATE.)

BEFORE entering upon a consideration of the "Hydrostatic arrangements of the horse's foot," which is the title of the subject I have the honour to bring before your notice to-night, I will briefly indicate, for the benefit of those who may not be already familiar with it, the homology and general structure of this interesting organ.

You are all familiar, I have no doubt, with this important generalisation of comparative anatomy—that the limbs of all vertebrate animals are homologous. The wing of a bird, the paddle of a seal, the fore leg of a horse, dog, cat, &c., are comparable with, and possess the same anatomical elements as, the arm of man. Differentiation in function has given them all, however, a corresponding change in structure, and so we find the middle finger of man represented by the fore foot of the horse; similarly the middle toe has its homologue in the hind foot. Although, strictly speaking, from its anatomical constitution the horse's foot really begins at the knee, the term is applied only to that portion of it formed by the hoof and parts contained within it. Thus defined, the foot has been aptly described as a "foot within a foot," and the terms "outer" and "inner" have been applied respectively to them. The outer foot is the hoof (homologue of the nail), composed of horn, and formed of two parts—a wall and floor. The hoof is accurately moulded upon the inner foot, and in shape these two structures resemble each other closely. The wall of the hoof in its anterior aspect stands at an angle of 50 degrees; traced backwards it not only diminishes in depth, but the angle becomes more and more acute. The wall is about half an inch thick; on its inner side, placed vertically, is found a series of horn-plates—in number five or six hundred, in size  $\frac{1}{8}$  to  $\frac{1}{2}$  inch, and running

the whole depth of the wall. These plates interleave with a corresponding series of fibrous plates on the inner foot. On the top of the wall is found a groove which lodges in part the coronary cushion—to be hereafter found to play an important part in the hydrostatic mechanism. The surface of this groove is dotted over with small pointed depressions which lodge papillæ—a collection of small blood vessels.

The floor of the hoof is also formed of horn accurately fitting on to the wall; in front it is hard and unyielding, behind more pliant and springy, which part is termed the frog. On the inner surface of the floor papillary depressions are found in great number.

The inner foot is formed principally of the pedal bone, which is crescentic in front and wedge-shaped, inclining forward. Like all other bones it is covered with periosteum, a vascular membrane, and to the periosteum of its anterior surface are attached the fibrous plates which interleave with the horn-plates of the hoof. The pedal bone is the last of the bones of the digit, and articulates above with the second, that again with the third, and so on to the leg.

We are now in a position to consider the hydrostatic mechanism, which it will be convenient to describe as formed of four parts.

The first is a highly vascular membrane enveloping the whole inner foot, dipping down between the fibrous plates and giving off papillæ to the under surface of the pedal bone.

The second part is a similar membrane similarly disposed upon the inner surface of the hoof; thus you will observe that, when the series of plates are in apposition, between them are found two layers of highly vascular membrane.

The third part of the mechanism is found in the form of a fibro-elastic cushion, containing a great quantity of blood in its close network of capillaries. This cushion is placed on the floor of the foot between the two vascular membranes just mentioned, and the pedal bone consequently rests upon it. It is wedge-shaped, directed forward; it is two inches in depth behind, and runs to nothing in front. This is the plantar cushion.

The fourth and last portion of the hydrostatic mechanism, and perhaps the most interesting part of all, is found in the coronary cushion, which, like the last, is composed of fibro-elastic tissue and is very vascular. It is found in the groove on top of the wall, and encircles the foot like a ring, being attached to the plantar cushion behind.

These various parts act and react together in the following manner:—

When pressure, as the weight of the animal, is transmitted down the bones of the leg, it is received upon the centre of the plantar cushion through the pedal bone; but since this cushion is wedge-shaped, and presents considerable resistance by means of its fibrous structure and the hydrostatic resistance of the blood contained in its substance, the pedal bone is driven forward and downward by the resultant of forces. This, however, would bring it in contact with the hoof-wall were it not for the interposition of the membranes before mentioned, and so the blood within these membranes sustains the pressure through the resistance of the hoof-wall. But why, you may ask, is the blood not driven away, and why are not the membranes crushed between the pedal bone and the hoof-wall, or cut in pieces by the horn-plates? Simply because there is no escape for it. The plates prevent it escaping from either side; the papillæ below swell up by the pressure and block it there, and above the way is completely stopped by the coronary cushion.\* We have seen that the coronary cushion was attached behind to the plantar; consequently, when pressure falls upon the centre of this cushion, the plantar, half of it is transmitted upwards, and the coronary cushion participates in this upward pressure, which causes it to swell, and so the papillæ on its surface are pressed upon and blocked, shoulder to shoulder as it were, and the pressure from the anterior surfaces, transmitted up the plates, is neutralised by a corresponding force above; for we have seen that both these forces are produced by the same cause—weight of animal,—and that they are equal.

Further, it is from these coronary papillæ that the hoof itself grows, so that increased pressure downwards reacts by producing papillary pressure; papillary pressure will argue papillary activity, and the result is an increased production of horn, and that means increased powers of resistance.

The papillæ on the lower surface of the pedal bone, and on the inner side of the hoof-wall, bear the direct downward pressure in conjunction with the hydrostatic and physical resistance of the plantar cushion itself.

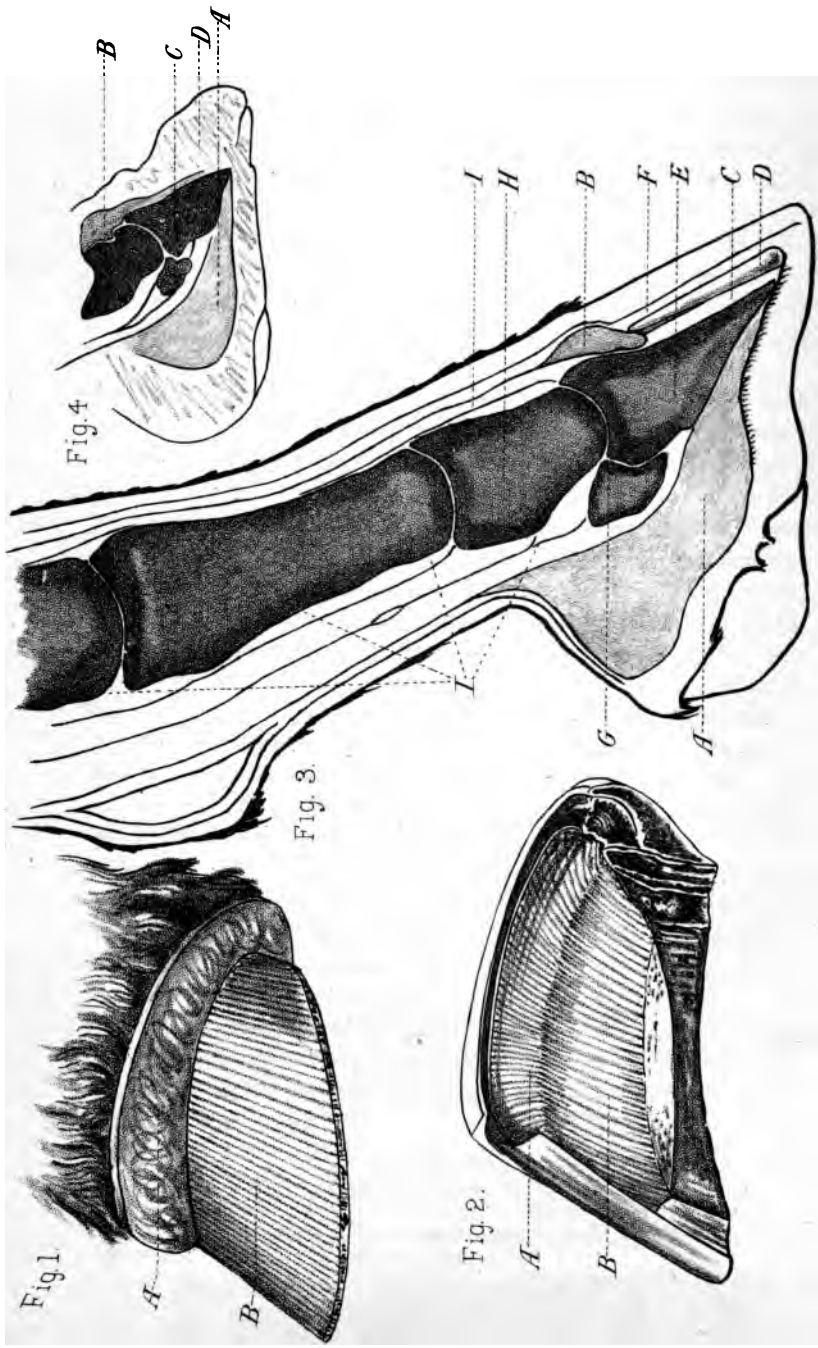
If it should occur to you to ask how do the delicate capillaries and tissue cells bear this pressure, I can only say it is by

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\* The coronary cushion also acts as a ligament to the last joint, and as a *ligament* of this nature is, I believe, unique.



**HYDROSTATIC ARRANGEMENTS IN THE HORSE'S FOOT.**



**Figs. 1, 2, and 3. After Bouley.**

**Fig. 4. Drawn by W. Moffat.**

protection of the same law which prevents fish and other organisms being crushed at low depths of the ocean—namely, the pressure is transmitted through them and borne at last by some hard, unyielding material.

Since fluid is practically incompressible, the compressing force must give way if the fluid is confined in a resisting case stronger than the primary pressure. This we have in the horse's hoof, and we have seen that the blood at the moment of pressure is confined, and that increase in pressure reacts by production of a resisting medium in the formation of the hoof, so that the weight of the horse is easily borne. However, so evenly balanced are those forces—Nature does really in some things show the utmost economy—that if one foot of a horse is not in use, from disease or otherwise, its fellow generally suffers greatly, for its molecular activity is not swift enough in action to compensate for such a sudden and great increase in weight. Friction is the result, and the result of friction is the proliferation of horn from the horn-plate layer, and this increase of horn not only forces out the hoof-wall but drives back the pedal bone and wedges it tightly.

Such a pathological condition is seen in Fig. 4, Plate V.

As an example of *conservation of energy* the horse's foot is perhaps unrivalled in the animal economy.

#### DESCRIPTION OF PLATE V.

##### FIG. 1.—INNER FOOT.

- A. Coronary cushion.
- B. Fibrous laminae or plates.

##### FIG. 2.—OUTER FOOT.

- A. Groove for coronary cushion.
- B. Horn laminae or plates.

##### FIG. 3.—SECTION OF FOOT.

- A. Plantar cushion.
- B. Coronary cushion.
- C. Fibrous plates.
- D. Horn plates.

E. Pedal bone.

F. Hoof.

G. Navicular bone.

H. Coronary bone.

I. Tendons.

##### FIG. 4.—FOOT IN DISEASE.

- A. Plantar cushion.
- B. Coronary cushion.  
(A and B much dried.)
- C. Pedal bone.
- D. Distorted hoof.

XIII.—*On Public Lighting by Electricity.* By Mr. H. A. MAJOR,  
Member of the Institution of Electrical Engineers.

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[Lecture delivered before the Society in the Banqueting Hall, City Chambers, 19th March, 1890.]

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(WITH PLATES.)

ELECTRIC Lighting in this country is entering on a new phase of existence, and public attention is consequently turned towards it with a fresh interest. Its success, on a small scale, having been thoroughly established, its development has carried it to an important place in the markets of the world. The establishment of distributing centres for electricity has produced a demand for electric current which is altogether on a different scale from the demand for isolated installations, and electricians now think as lightly of installations of ten, twenty, or thirty thousand lamps as three years ago they did of installations of a few hundreds.

The first scientific and practical problems connected with the production and distribution of electricity having been solved, the next step is to attack the economic problem, and the natural tendency is to centralise the production so as to reduce its cost. This, of course, brings in its train new scientific and practical problems to be solved. The methods of production and distribution have to be modified to suit the new conditions.

Nearly a hundred years of lighting by gas have not exhausted the possibilities of improvement. The experience of a century of gas distribution should, however, if properly used, be of immense service to its new and formidable rival. It is very important that it should be borne in mind that, while the fluctuations in the demand for the two lighting agents are found to be very similar in character, the problem of distribution is very different.

For some time to come it is probable that the price of electric light will remain considerably higher than the price of gas, and that while this remains so there is no likelihood of its general adoption to the exclusion of gas. This point has, I think, been rather overlooked both in the legislation on the subject and also in many of the projected schemes for electric supply.

The Electric Lighting Act (1888) speaks of the definition of areas of supply, and promoters of lighting schemes are very apt to

forget that, however feasible on paper an economical scheme of distribution by networks of wires may appear, the problem is, rather, the distribution to consumers scattered over the area and not by any means equally distributed.

Thus, while some classes of shopkeepers find it decidedly to their advantage to adopt the electric light, many of their neighbours find that their purposes are as well served by the cheaper illuminant; and the occupiers of warehouses and other business premises, who find it hard enough to make ends meet, are not ready to use the high-priced luxury, the cost of which to their more prosperous neighbours is a matter of small importance. The same conditions apply in residential localities. To some persons the addition of £20 or £30 a-year on the lighting bill is only an item among much larger items of expenditure for luxury or convenience, while to others with overstrained incomes or economical inclinations gas is more convenient than electric light. Keeping this in mind, it is evident that the system of distribution must be such as to adapt itself to a scattered, but steadily-growing demand.

The low price and good quality of gas, coupled with the fact that the lighting industry is largely in the hands of the municipal authorities, have tended to delay progress. Public bodies are naturally averse to taking up an industry which is but partially developed, and which has not settled down to a steady ratio of supply and demand. The uncertainty as to which is the best of the many competing methods of generating and distributing electricity, and as to whether the supply can be profitably undertaken by the corporations, has deterred them from taking action; while private enterprise has been somewhat held in check by this uncertainty, and also by legislative restrictions.

But the slower advance has not been without its advantages to the industry. Enormous strides have been made during the past ten years in improving the efficiency of generating plant and other accessories, and these have given the work which has been, and is being, done a more permanent and satisfactory character. Still, much has yet to be done; and, while the present impulse seems to proceed from a comparatively firm basis of knowledge and experience, it is to be hoped that what has still to be done will continue to proceed rather on the safe lines of steady and gradual progress, than by haphazard and speculative methods of *exploitation*, such as are apt to obtain under the circumstances that have been brought about by the Electric Lighting Acts, which have forced private

companies and corporations into the projection of enormous schemes, such as should rather be the outcome of gradually-acquired experience than of the visions of enthusiasm, or the unnatural forcing of insufficiently developed systems.

We may now take a survey of the means at present available for the production and distribution of electricity. This commodity of electric current, although strictly speaking a natural product, is not naturally produced in a form available by known means for the service of man. It is, therefore, necessary to produce it artificially by the expenditure of some form of energy.

The possible methods of producing electric currents are many, but at present the cheapest and most convenient method is by the transformation of mechanical into electrical energy. Speaking broadly, the only source of mechanical power available on a large scale for this purpose at the present time is the steam engine. The utilisation of water power for electric-lighting purposes is limited by the heavy cost of acquiring rights to the source of the supply, and this first cost cannot be incurred until the demand for electricity has increased to a sufficient extent to give a commensurate income.

Although it is very well known that the steam engine is an inefficient producer of power, it is the most convenient, and, fortunately, it is ready to hand and well in advance of the requirements of the case in point.

We need hardly go into any description of the steam engines used for electric lighting, for although they are in some respects specialised for this function, they are, on the whole, identical with engines used for other purposes. There are plenty of engineers on the Clyde who could be entrusted with the biggest orders that electrical engineers are likely to place for some time to come.

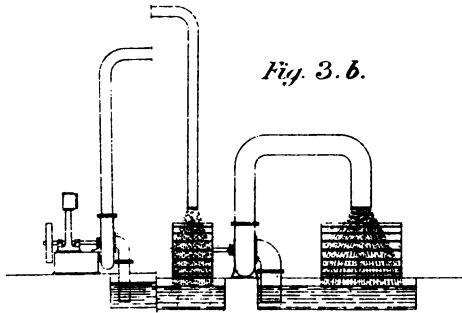
The means of conversion of the power of the steam engine into electric power are now also at hand, and fortunately we are able to say that the loss of power in this part of the process is comparatively small. The total loss of energy in the production of electric current is equal to about 91 per cent. of the original energy of the coal. Of this loss about 75 per cent. takes place in the boiler, furnace, and chimney; 15 per cent. occurs in the engine; and about 1 per cent. in the dynamo.

#### DYNAMO MACHINES.

For our present purpose it is unnecessary to enter into any



Fig. 3. b.



ANALOGUE IN HYDRAULICS OF ENGINE DRIVING DYNAMO  
 PIPE AT HIGH PRESSURE, WORKING WITH AT CONSTANT CURRENT  
 CIRCUIT, WORKS IN SECONDARY CIRCUIT AT LOW PRESSURE.

Fig. 3. a.

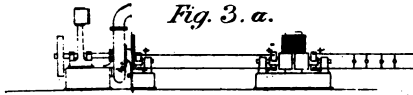
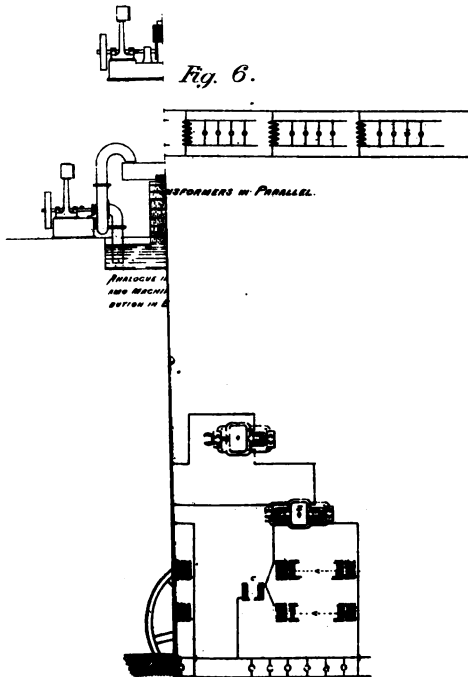


Fig. 6.



PERFORMERS IN PARALLEL.

ANALOGUE IN  
 AND MACHINE  
 BUTTON IN B

detailed description of the dynamo machine. It is simply an apparatus for producing a difference of electric pressure between two points. The analogy between hydraulic machinery and electric is often used, and may serve to make this point clear.

In Fig. 1*a* (Plate II.) is represented a steam engine driving a pump which produces a difference of pressure between the supply and delivery, lifting water to a height, in falling from which it does work. The dynamo does not manufacture electricity any more than the pump manufactures water—it simply produces a difference of electric pressure between its terminals. The upper diagram may be taken as representing a dynamo machine with one terminal connected to earth; the lower diagram is a more complete analogy to a dynamo machine working in a closed circuit.

We shall have occasion still further to use this analogy in speaking of distribution.

Broadly, dynamo machines are divided into two classes:—

1st. Those in which the currents of electricity generated in the armature coils are alternating in direction. We may be permitted to compare this class of dynamo to a double-acting pump with a separate discharge from each end of the cylinder, so that the flow is reversed at each stroke. As shown in Fig. 1*b* (Plate II.), the flow in any part of the pipe would be alternately from right to left and from left to right.

2nd. Those in which the currents are made to flow in one direction only, and are called continuous-current machines.

These machines have grown in size from the diminutive laboratory instrument to those now regularly in use requiring up to 300 horse-power to drive them. One machine has been constructed to convert 1,500 horse-power into electrical energy. Still larger machines are in course of construction.

The advance in the efficiency of these machines is still more wonderful than their advance in size. Ten years ago the best machines in the market lost at least 40 per cent. of the energy imparted to them; now the loss has been reduced as low as 6 or 7 per cent. Much of this improvement has been due to the development of instruments of precision for measuring the power developed by the dynamo. There have been many workers in this field of scientific research, and there is no industry which has been so much assisted by the enthusiasm and patient labour of pure scientists as the industry of electric lighting.

Ten years ago there were no convenient and accurate instruments available for what are now the most ordinary requirements. Now instruments are available for every purpose in connection with the most delicate and accurate investigations in every department of practical work. This is largely due to Sir William Thomson, who has not only done splendid service in determining the laws which govern electric phenomena, but has himself devised and provided instruments of precision for determining and recording their effects.

#### STORAGE BATTERY.

The Storage Battery, or Accumulator, performs an important function in some systems of electric production. This apparatus, although for all practical purposes properly described as a reservoir or store of electric energy, is simply a means of converting the energy into a form in which it will remain for an indefinite time ready for reconversion into power. This is effected by producing on two sets of lead plates chemical changes of such a kind that a difference of electric pressure is produced between them, until by connecting them together by a conductor electric power is expended, and the plates return to their former state.

#### TRANSFORMERS.

One of the most important developments in electric-lighting apparatus has been the introduction of the Transformer, which is an apparatus for using high-pressure currents of electricity in the primary circuit for the production of low-pressure currents in the secondary, or *vice versa*. Both continuous and alternating currents may be used in this way.

Returning to the hydraulic analogy for the purpose of graphic illustration, it will be seen how a motor using high-pressure current may be used to excite and drive a dynamo producing a low-pressure current—Fig. 3, *a* and *b* (Plate II.) This is the method adopted for transforming continuous currents. For the transforming of alternating currents, the apparatus more definitely called transformer or secondary generator is used. In principle it is the same at bottom as the continuous-current transformer, but with this difference, that in the continuous-current transformer the secondary currents are produced by mechanically moving the secondary coils in the magnetic field produced by the primary, while in the case of alternating currents the field itself is varied,

and induces currents in the stationary secondary coils. It is found that the transforming of alternating currents is effected with much less loss of energy than the transforming of continuous currents, and is therefore much more economical.

#### METERS.

Another important piece of apparatus in connection with the supply of electricity is the Meter. Many devices have been produced for the purpose of measuring the electric current and recording the quantity used. We have here four specimens—by Aron, Schallenberger, Chamberlain and Hookham, and Ferranti.

The first of these is slightly different in principle from the others. Two pendulums are arranged in a system of differential clockwork. So long as the pendulums, which are of the same length, are swinging at the same beat no record is made, but the passage of the current is made to accelerate the beats of one of them, and a reading is given on the dial which shows the quantity which has passed.

In the others the mode of action is to make the current perform work in rotating a disc or an armature, the coils being so proportioned that the number of rotations is exactly proportional to the quantity of the current.

#### INCANDESCENT LAMPS.

The Incandescent Lamp is now no longer simply a scientific curiosity, but an article of daily use to many of us ; but I wish specially to speak of it here as an important factor in the question of public distribution. As already pointed out, the dynamo machine is, as regards efficiency, within a very short distance of absolute perfection. The losses in the conductors and other parts of the system are reducible to a very small amount, and it is in the lamps themselves that we must effect an improvement if we are to look forward to the universal adoption of the electric light.

Now, without any prophetic vision of new methods of utilising electricity for the production of light, we see in the incandescent lamp the possibility of vast improvement. As you are aware, the lamp consists simply of a thread of cotton or other vegetable fibre, treated in such a manner as to remove, so far as possible, all other substances from it, and leave only pure carbon. This carbon thread is heated by the passage of the current, and when it is

raised to incandescence it gives off light. This light at the normal incandescence of the lamp is about one candle-power for three foot-pounds of energy, and the carbon is found to last for a reasonable time when subjected to this temperature. It may, however, be subjected to a much higher temperature without breaking up, and the light produced is enormously greater in proportion to the energy expended.

Since the invention of the incandescent lamp great strides have been made in the direction of improving the carbons so as to permit of their use at a higher temperature without unduly shortening their life. These improvements are still going on, and it is, I think, not too much to expect that by the time the present patent rights have expired we may have lamps of all sizes in the market which will need only half the energy required by those now before us to produce the same quantity of light. That this is no impossibility is demonstrated by the fact that this expectation is already accomplished in the "Sunbeam" (incandescent) lamps which I now show you.

The arc lamp is twice as efficient as the "Sunbeam" lamp.

#### METHODS OF DISTRIBUTION.

The methods of distribution for public lighting naturally take their rise in the methods previously adopted for private lighting. Fig. 2, *a* and *b* (Plate II.), is a return to the water analogy as a help to graphic representation of distribution. Here the same current is utilised step by step in its fall of pressure, and the work is described as being done *in series*. One conductor passes throughout the series and, as the size of the conductor is regulated by the *quantity* of the current, it will be seen that the conductor for each is large enough to carry current for the whole.

Keeping this figure in mind, we may look at Fig. 4, *a* and *b* (Plate II.), in which is represented the *parallel system* of distribution.

Here the pump or dynamo does the same total work as before, but in a different form. The current is four times the quantity of the series current and at one-fourth the pressure. The work done in the external circuit at each of the four points is the same, and the difference in pressure across each step is the same, but the main current is divided up into four portions. The main conductor in this case has to be large enough to convey four times the quantity of current.

To fix the analogy more clearly, let us bear in mind that series distribution corresponds to an arrangement of mills on a river where each uses the water in turn, as it step by step gives up its energy on its way to the sea; parallel distribution corresponds to the arrangement in a system of water distribution in a town where all the power is expended at one stage to a multiplicity of consumers who take each the full power of the quantity of water used at the points of application on the same level.

In these diagrams we have shown the water at work turning wheels. The electric current for our present purpose is, of course, used not for turning wheels but for producing another kind of motion, which exhibits itself to us in the form of heat and light.

We have here an arrangement of lamps in parallel, each taking  $\cdot 64$  ampère, at a pressure of 100 volts. We have also an arrangement of lamps in series, each taking  $\cdot 64$  ampère and 100 volts. Both are absorbing the same amount of energy, but in the first case the current is 15.36 ampères, and the pressure 100 volts; while in the second case the current is only  $\cdot 64$  ampères and the pressure 2,400 volts. These simple arrangements are modified in various ways to meet the requirements of distribution at a distance, or over an extended area.

In transmitting electric currents, as in transmitting water, steam, or gas, there is the difficulty of maintaining a uniform pressure throughout the system. Now, in the case of electric lighting it is of paramount importance that the pressure should not only be equal throughout the system, but that it should be uniform from time to time under all conditions of load. It is this requirement which modifies the arrangement, as the system is extended. The first step is to increase the pressure and to reduce the quantity of the current, because the loss in the conductors is proportional to the quantity of the current.

On the simple series system, as illustrated by Fig. 2, *a* and *b*, this increase in pressure is limited by the difficulty of getting cables insulated sufficiently to prevent the escape of the current, and by the complication of the arrangements when the same conductor has to be led from one lamp to another throughout the whole system. A modification of the series system has been devised by M. Bernstein for overcoming these difficulties.

Fig. 7 illustrates a method which has been applied in several cases and has many points in its favour.

Fig. 5 shows a method in which alternating currents of electricity are used by transformers in series to give a low-pressure current for the lamps in parallel. This was the method adopted in the original experiments on the Underground Railway, and at the Grosvenor Gallery. It is largely used in America and on the Continent.

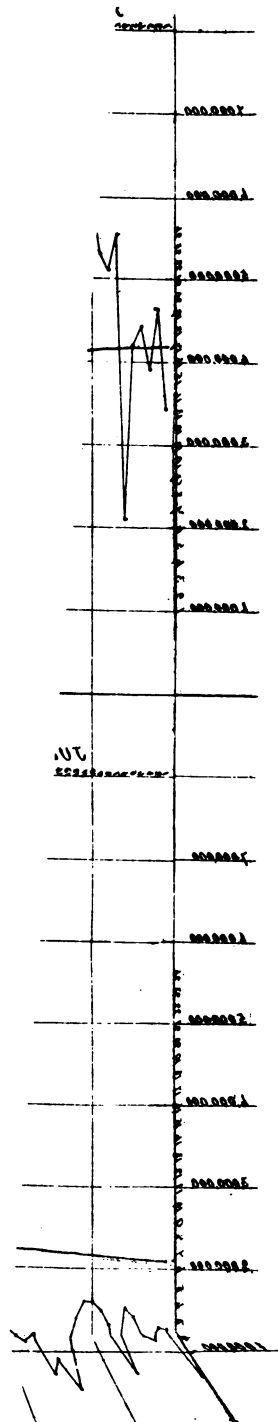
At Fig. 8 is shown the method of using storage batteries on the series system for the supply of lamps in parallel. In this arrangement is also embodied the continuous-current transformer.

Fig. 6 indicates a modification of the parallel system in which continuous-current transformers and storage batteries, or each independently, or alternating current transformers, may be used. In this arrangement the primary current is raised to as high a pressure as circumstances will permit, and is transformed at the point where it is to be utilised into low-pressure current.

At Fig. 4, *a* and *b*, we return to simple parallel distribution, and some prominent engineers are of opinion that the modifications which have just been described are unnecessary, and that it is possible to carry on public lighting from a number of small centres or to submit to the loss of energy and extra complication of distribution which working from a distance entails. They propose to maintain a constant pressure under varying conditions of load by means of separate conductors from the generating station to various points in the area of supply. These are called feeder mains, and the pressure on them is regulated by artificial means and by hand.

Having now seen how electricity is produced and its distribution is modified for extended operations, we may proceed to the study of the nature of the demand for light; and, as it is easier to see what is the state of matters from a concrete case than by any amount of abstract reasoning, we may look at the demand for light in Glasgow as exhibited by the records of the gas supply.

By the courtesy of Mr. Foulis, Corporation Gas Engineer, I am able graphically to represent by a series of curves prepared from his records what was the nature of the demand for light in Glasgow throughout last year. (Plate III.) Of course, this diagram is of small service for quantitative purposes, but we find that it accords closely with the results of experience of electric lighting in the mode of fluctuation. It will be seen that on Sundays the consumption of gas is very much less than on other days, and serves as an indication of the ratio of domestic to commercial consumpt. In the foggy



stations, the idea being to economise coal and labour by running the engines only when the load is heavy. The use of storage batteries in this manner is finding favour in many quarters.

It is evident, however, that it is not correct to call this *provision for storage*, as the effect of throwing the whole load of the station upon such a battery, even for one hour, would probably result in its total destruction. The advocates of this system of working have yet to gain the experience of supplying current on a large scale, as all the stations which have been at work on this method hitherto have battery power much in excess of the proportion intended when the station is working to its full capacity.

It is probable that, as the stations increase in size, it will be found that the use of storage batteries, while becoming proportionately more expensive, becomes less necessary, because an idle engine and boiler cost in interest and depreciation less than one-fourth the cost of a storage battery, and form a stand-by which in the long run is quite as reliable. It is found in practice that when trouble does occur which leads to interruption in the light, it is not usually at the generating station where the fault occurs, but in the conductors, and a *year's* storage at the station in such a case is not worth a pin's fee. But the storage question is not so much a question of practical politics as the question of distribution.

After the storage question is settled, as before it is discussed, comes the question of choice between high and low pressure systems of distribution. The difficulties of both have yet to a large extent to be overcome, and only practical results can demonstrate which is right. The advocates of both methods are equally confident, and it would be dangerous to prophecy what the final result will be; but there is no doubt that the present impulse to electric lighting is largely due to the success of the high-tension system of alternating currents with transformers in parallel. The success of this method has led to an expansion in the views of electrical engineers, and the projection of enterprises on a scale previously unthought of.

Much of the credit of this is due to Mr. S. Z. de Ferranti, a young engineer, who developed the Grosvenor Gallery installation, in Bond Street, London, from a small local station supplying a few hundreds of lamps to its present capacity of about 12,000 lamps of 8-candle power, or double the size of Edison's great station in Brooklyn. Out of this station has grown the huge

months there is a very considerable fluctuation in the daily quantity, which is clearly brought out in the curves for January, February, and November.

It will be seen that, as might be expected, the demand for artificial light follows closely the variations in the length of the night. On Plate III. is drawn a thick black line which has no relation to the general object of the diagram, but which in relation to the base line of the Plate shows the daily variation in the length of the night, the ordinates being highest when the night is longest. This line is plotted alongside the curve, showing the demand for light, and shows that the average hourly demand during the hours of darkness is much greater in winter than in summer from a cause which is easily understood on referring to the diagram in Plate IV., which may be taken as showing two representative days. On the 26th December of last year took place the greatest consumption of Glasgow gas on record. On the 31st July the consumpt was nearly at its minimum for last year. An examination of these curves shows that the maximum hourly consumpt took place at about 6 p.m. on the 26th of December. This is the time at which, during the portion of the year lying above the night curve in Plate III., the greatest demand of the day took place, so that when the sun is good enough to put in an appearance up till that time in the evening the average hourly consumpt for the day is considerably reduced.

Now, on the face of these curves there is an evident argument for storage of energy. For one hour of the day in winter the demand is enormously in excess of the average, and in summer the case is similar, although the extra demand is at a different time of the evening.

It is an undoubted hardship to be under the necessity of keeping machinery for a whole year waiting for this critical 26th of December, when the demand for one single hour is in excess of the maximum throughout the remainder of the year.

Unfortunately, however, the storage of electricity is very costly, and, although on a small scale this extra cost is sufficiently counterbalanced by the saving in attendance to warrant its use as a luxury, on a large scale, where the cost of attendance is proportionately small, the element of cost soon fixes a limit to the practicability of storage. The most enthusiastic advocates of storage batteries do not, so far as I am aware, propose to provide storage for more than a small portion of the total output of central

stations, the idea being to economise coal and labour by running the engines only when the load is heavy. The use of storage batteries in this manner is finding favour in many quarters.

It is evident, however, that it is not correct to call this *provision for storage*, as the effect of throwing the whole load of the station upon such a battery, even for one hour, would probably result in its total destruction. The advocates of this system of working have yet to gain the experience of supplying current on a large scale, as all the stations which have been at work on this method hitherto have battery power much in excess of the proportion intended when the station is working to its full capacity.

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enterprise at Deptford. The boldness of this scheme staggered the older engineers, and has led to much head-shaking and evil prophecy. The novelty of the Deptford scheme is the enormous increase in the pressure proposed to be used, which is more than four times what had previously been the highest in use; and in this respect and to this extent, it must be admitted, the work is experimental. No one, however, can fail to admire the indomitable pluck of the man who is persevering in the face of much discouraging criticism with his gigantic experiment. That this experiment should be made is of immense public advantage, and the great difficulties which have already been successfully grappled with and overcome encourage the hope and expectation of ultimate success.

In speaking of the various methods of distribution, we have assumed that the conductors are insulated sufficiently to prevent loss by leakage of the current. In practice it is essential that this should be a first consideration in laying a conductor. No matter how large it is, the conductor which is not sufficiently protected by insulating material would deliver a very small quantity of the current entrusted to it. This necessity for insulation, which, of course, increases as the pressure of the current increases, to some extent holds the balance of cost as between high and low pressure systems of distribution, so that the battle has to be fought on other grounds besides mere economy.

Connected also with this question of insulation is the matter of danger to life. Danger is undoubtedly present where electricity is used at pressures exceeding 200 volts, either in continuous or alternating currents. It should be understood, however, that the mere touching of a wire carrying a high-tension current does not necessarily mean death. Cases have undoubtedly occurred where persons have received shocks at a pressure far above what is considered the safe limit and without serious injury, but there is no doubt either that deaths have occurred directly attributable to electric shocks.

While the electrical engineer must not shut his eyes to the danger of the high-pressure methods of distribution, he need not on that account abandon their use: his clear duty is, if he finds it convenient to use them, to do so in such a manner as to make them perfectly safe. No one would think of saying that because the use of high-pressure steam is dangerous we must have no steamship "City of Paris." The argument of danger is only used to

ensure careful workmanship and the best obtainable materials, and the passengers are willing to take the extra risk if, after all, there is any.\*

In the face of much exaggeration it is comforting to read the report of the New York Board of Coroners on the subject, communicated by the American correspondent of the *Electrician*, as showing how comparatively innocent electricity is of fatal accidents:—

“It appears that 21 deaths were directly attributable to gas, 80 to being run over by vehicles, 36 to falling bodies, 54 to burns and scalds, and 9 to electricity. Of these 9 nearly every one, as the record shows, was directly attributable to the carelessness of the workmen and linemen employed in connection with the supply of the current, and in but two cases, as far as I am aware, was the death that of a private citizen. In view of such a showing one wonders how it is that it has been so easy to manufacture public sentiment against electricity, and to alarm not only New York but pretty well the whole world.”

That these accidents have occurred is, of course, lamentable. The extraordinary multiplication of overhead conductors in New York—many of them run without any special regard for public safety—explains in some measure how they occurred.

The provisions of the Electric Lighting Acts and the Regulations issued by the Board of Trade have rendered it impossible that such a state of affairs can obtain in this country. All cables for electric lighting are ordered underground two years after their erection overhead.

Various forms of cable and other apparatus have been devised for underground distribution, and I have collected a typical set of the various methods, from which it will be seen that there is at least a good selection to choose from. The conditions of soil and climate must to a large extent affect the choice in each case.

In conclusion, I may be allowed to express the hope that in Glasgow before long the electric conductor shall lie down with the gas pipe, and the light of a new era shall spread its radiance over every quarter of our city.

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\* Additional force is given to this argument by the events which have occurred between the delivery of this lecture, and its being put in type. The terrible devastation caused by the misadventure to her engines will not prevent the vessel going to sea again so soon as the damage can be repaired.

XIV. — *Cyanotype Reproductions of Seaweeds*. By WILLIAM LANG, jun., F.C.S., President of the Glasgow Photographic Association.

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[Read before the Society, 6th November, 1889.]

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(WITH CYANOTYPE PLATE, FORMING FRONTISPIECE.)

THE two volumes which it is my privilege this evening to bring before the members of the Philosophical Society are unique in character, whether they be regarded from a photographic or from a natural-history point of view. We have here a series of the British Algæ reproduced photographically, and that by a process which may be reckoned as one of the older photographic methods. The blue process, to give it its more familiar title, dates as far back as the year 1842, and was devised by Sir John Herschel. He it was who first demonstrated that light acts on the more highly oxidised iron salts, known as *ferric*, reducing them to a lower state of oxidation, to what is termed the *ferrous*; and, as these reduced products manifest with certain reagents a different series of reactions from what the original substance gives, he was enabled to show in a very pronounced manner the effect produced by exposure to light. Herschel brought forward many methods for printing with salts of iron; but that particular process with which we are more especially concerned this evening received from him the name of the Cyanotype. The iron salt which is generally employed in the production of this class of pictures is the ammonia-ferric citrate, and a solution of it may either be brushed over the paper *per se*, and, when dry, exposed to light under the object to be copied, and afterwards, by immersing the print in a solution of potassium ferricyanide, we find that where the light has acted there will be formed a blue product; or the potassium-ferricyanide solution may be mixed along with the ferric-citrate solution in the first instance, when a simple immersion in water is sufficient to bring out the picture. The process remains in use to the present day, and is employed by engineers and draughtsmen for the reproduction of drawings, plans, &c. Specimens of prints obtained according to the method indicated you see here, the lines of the original being reproduced in white on a blue ground. By a modification of the foregoing process it is possible to reproduce the lines of the drawing blue on a white

ground. Both papers are prepared commercially. A specimen of the results obtainable by the paper last described is to be seen on the wall. It is generally known as Pellet's paper.

Regarding the permanency of the cyanotype process, we have in the two volumes before us sufficient evidence that prints produced by the blue process are lasting and enduring. Although it is more than thirty years since these impressions were obtained, the brightness and freshness, nay, in some cases, the vividness of their character would almost induce us to believe that the prints had been but recently produced.

It may be interesting to give the following particulars regarding the volumes and their contents. Opening the first volume we find the initial page has the title "British Algæ, Vol. I.," printed in white on a blue ground. Obviously the lettering had in the first instance been printed on a white sheet of paper with ordinary ink, and, this being superimposed on the sensitive paper, the printing was done in a manner similar to that employed when dealing with the ordinary photographic negative. The following page has the inscription "Photographs of British Algæ—Cyanotype Impressions." The third page explains the purport of the work, and is a facsimile of the hand-writing of the producer. It reads as follows:—

"The difficulty of making accurate drawings of objects so minute as many of the Algæ and Confervæ has induced me to avail myself of Sir John Herschel's beautiful process of cyanotype to obtain impressions of the plants themselves, which I have much pleasure in offering to my botanical friends.

"I hope that in general the impressions will be found sharp and well-defined, but in some instances, such as the Fuci, the thickness of the specimens renders it impossible to press the glass used in taking photographs sufficiently close to them to ensure a perfect representation of every part. Being, however, unwilling to omit any species to which I had access, I have preferred giving such impressions as I could obtain of these thick objects to their entire omission. I take this opportunity of returning my thanks to the friends who have allowed me to use their collections of Algæ on this occasion.

"The names refer to Harvey's Manual of British Algæ. I have taken the tribes and species in their proper order when I was able to do so, but in many cases I have been compelled to make long gaps from the want of the plants that should have been next inserted, and in this first number I have intentionally departed from the systematic arrangement that I might give specimens of very various characters as a sample. "A. A."

The fourth page takes the form of a dedication—"To my dearest father this attempt is affectionately inscribed." Then follow 192

plates of the various specimens reproduced, each one having its botanical name affixed.

The second volume contains 107 plates to which there fall to be added 80, which have apparently been put in as an appendix, making in all 187. The number of plates in the two volumes is therefore 379. In a note at the end of Vol. II. are the following remarks :—

“Should any of the plants which are omitted, or of which the impressions are from poor specimens, be obtained, a supplementary part may at some future time be added to this work.

“A. A.

“H.P., September, 1859.”

Through the kindness of Mr. James Britten, Department of Botany, British Museum, I am enabled to give a few details regarding the authorship of these volumes. “A. A.” were the initials of Mrs. Atkins, who lived for many years at Halstead Park, Kent, and died there in June, 1871. She was the daughter of John George Children, Assistant Librarian (*i.e.*, Keeper of the Zoological Department) of the British Museum from 1816 to 1839. On his retirement he lived with his daughter at Halstead; he died January 1, 1852, and a memoir of him by Mrs. Atkins was privately printed in 1853. Mrs. Atkins had a large collection of British plants, which at her death was bequeathed to the British Museum, and is now incorporated in the British herbarium there.

How many copies of these cyanotype impressions were issued by Mrs. Atkins I have no means of knowing. From the great labour entailed in their production it is obvious that only a very few could possibly have been got together. Mr. Britten informs me that there is one in the British Museum. The number of impressions is, however, 411, against 379 in the present volumes, but the introductory prefatory matter is wanting. My informant is of opinion that a set is also to be found at Kew.

The remaining point to be noticed in connection with the cyanotypes shown this evening is the fact that they originally belonged to the late Robert Hunt, F.R.S. In his early days Hunt worked assiduously at photography, and it is extremely probable that he received these impressions direct from the author. He was the author of various manuals bearing on photography, but his most important work is his “*Researches on Light*.” To Hunt we are indebted for the use of iron sulphate as a developer in the collodion process.

XV.—*On Club Mosses: Past and Present.* By F. O. BOWER,  
D.Sc., F.L.S., Regius Professor of Botany in the University  
of Glasgow.

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[Lecture delivered before the Society, 30th April, 1890.]

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To an audience of this kind, living in Scotland, the club mosses of the present time are plants which are sure to be in one way or another familiar. Anybody who has walked over one of our hillsides will have learned to recognise the stag's-horn moss, as it is called; and not only from observation on the hillside, but in other ways *Lycopodium*, or club moss, will be a familiar object: even when we go to the theatre and witness such plays as "King Lear" and "Macbeth" there are certain scenes where artificial lightning is introduced, and it is commonly by blowing the spores of *Lycopodium* through a flame that this artificial lightning is produced. Again, in the druggists' shops the spores of *Lycopodium* are well known, being used for keeping pills separate from one another. Further, to those who study the history of the clans the club mosses will no doubt have an interest, for it is well known that one species, *Lycopodium clavatum*, is the badge of the Clan Sinclair, and *Lycopodium alpinum* is the badge of the Macraes, and so on. In various ways we shall therefore be already familiar with that family of plants which I have chosen as the subject of my lecture this evening. But before entering on the description of the Lycopods, I shall first refer to the position which this family holds in the main system of plants.

By comparison of the plants at present living upon the earth, we are able to arrange them, according to their form and their mode of life, in a series. We can recognise some as being relatively simple in structure and mode of life—these we should place low in the scale; we recognise others as being more specialised in their structure and mode of life—these we put higher in the scale; so that, starting from the lowest extremes, we may arrange the

whole series of plants in a sort of chain. I will now briefly indicate to you what this chain is. First of all, the lowest are those commonly called Thallophytes; these include Algæ, or sea-weeds as they are generally called, and the Fungi. These are plants which live for the most part characteristically in a wet habitat, especially the Algæ, which are from the evolutionary point of view the most important and typical representatives of this, the lowest series. Passing upwards from them, we come to a large series which are called the Bryophytes, including mosses, and those green, flattened, and expanded organisms the liverworts, which usually grow closely applied to moist soil. These show a greater specialisation in their mode of life, and are rightly to be placed in a position higher in the scale than the preceding series. From these Bryophytes, or from forms allied to them, there have been derived three main series of plants which are more characteristically those of a terrestrial habit. They are grouped together in a large series which we recognise as the Vascular Cryptogams. One of the series is the Equisetaceæ, which have played in past times a very important part. These Equisetaceæ lead on to no further plants of a higher type, and accordingly this is what we should call a blind branch of development. The other two branches of the Vascular Cryptogams have, however, led on to higher forms. The next one I should mention would be the Filicineæ, the series of the ferns, occupying an intermediate position between certain of the moss-like plants, and leading on by a further development to such plants as the Cycads. There we may leave them, because ferns are not the subject of our lecture, and pass on to our own special subject of this evening, namely, the club mosses, or Lycopods.

This family consists of, firstly, those which we now have living upon the earth; and, secondly, those of which we find traces even in early geological periods. The Lycopods are not, like the Equisetaceæ, a blind branch of development, which leads no further; but as far as our knowledge, as based on comparison, goes at present, it seems extremely probable, almost certain, that from the Lycopods were developed the family of the Conifers, or cone-bearing plants, such as the firs and pines. Now you will see the view which we shall take as regards these Lycopods. We shall recognise in them an intermediate series, leading up from the moss-like plants to those with which we are already familiar—namely, the common pines or firs.

Having now indicated the position in the general system which, according to our present views, the Lycopods hold, we may go on to consider those forms of this family which we have now living upon the earth ; and, as is usually the case in lecturing, it would be well to start with some forms familiar to us all. I have therefore taken care to obtain a considerable supply of our three commonest species of *Lycopodium*, with a view to your making yourselves acquainted with the main characteristics of these three species, though no doubt they are familiar to many of you already. Taking first *Lycopodium Selago*, you have here a plant which has a somewhat massive axis, and upon that axis or stem there are inserted a large number of small leaves of a simple form. If you look at the axes themselves, and examine how they branch, you will see that there is a characteristic point to be recognised about them. To put it diagrammatically, the main axis grows up to a certain point and then branches off into two parts, which are precisely equivalent to one another. That is what we should call a "dichotomy," and I draw your attention at once to this dichotomous stem, because, though not universal for the club mosses, it is rather a characteristic feature. If you turn for a moment to this stag's-horn moss, as it is called, and examine the branching, you will see that it is not exactly dichotomous, and accordingly, though this dichotomous branching may be recognised frequently, it is not universal throughout the family. When we come to examine the geological forms, you will see that dichotomy is perhaps more distinct and stereotyped in them than in the modern ones. Then, further, if you examine the roots of any one of these species—and of course in the specimens dragged up as these have been you can hardly expect the root system to be very perfectly preserved,—you will be able to observe that there are in the roots, which arise from the lower parts of the stem, dichotomous branchings of a similar nature to that which I have alluded to in the axis.

As regards the simple form of the leaves, I would draw a comparison between these Lycopods and some of the common Coniferæ. I have brought in a twig of *Thuja*, and you will see on it that simple type of leaf, with a rather broad basal cushion, which is characteristic of the Lycopods. The whole external surface of the stem may here be seen to be covered by these basal cushions, and this character may be clearly recognised in many of the geological forms. It is seen repeated in some, at all events, of

the coniferous trees ; and it is on such grounds as this, and also on the characters of the internal tissues, and of the reproductive organs, that we assign to the Coniferæ the position I have just stated.

I will now go on to point out one or two of the less familiar forms of the genus *Lycopodium*. Here is another species which is not so common, namely, *L. annotinum*. It is a native of this country, being found on some of the higher mountains of Scotland, and is present in considerable quantities in Norway and elsewhere. You would recognise the same characteristics here as in the other specimens, but in addition there are present upon this specimen large cone-like buds at the ends of the branches called strobili, or fruit-bearing branches. Our own native species are relatively small plants, but among the tropical forms there are some which are distinctly larger ; and I have brought from the University herbarium two specimens in order to illustrate those of the modern species which approach most nearly to the gigantic *Lycopods* which are so prominent among the flora of geological times. The first is practically a similar plant to *Lycopodium Selago*, but is much larger ; it is the species *Lycopodium phlegmaria*, which grows to the length of more than two feet. The strength of the axis is insufficient for supporting the whole weight of the head, which therefore has a drooping habit. This habit appears also to have been the characteristic of certain of the geological forms, and that conclusion is to be drawn partly from the actual form of the fossil remains, and partly from the fact that the stems are relatively small and of weak construction in comparison to the bulk of the heads which they had to support. This, then, will suffice to give us some idea of the nature of the comparatively small forms belonging to the genus *Lycopodium*, or club mosses, which now live upon the earth.

We may pass on to consider, for a few moments, certain points of the internal structure of these, because we are tolerably well-informed of the internal structure of some of the geological forms, and we shall require certain facts regarding the internal structure of the modern forms for comparison with the ancient. If you make a transverse section through the stem of *L. clavatum* the section will appear circular, with occasional projections here and there which correspond to the position of the leaves ; and in each of these you will see a small round patch of tissue, which is a vascular strand. This passes out from the leaf longitudinally up to its tip. Smaller strands may be seen dotted here and there at

points nearer the centre, while the centre of the transverse section would be occupied by a large strand of tissue, called the vascular cylinder. Supposing you cut now, instead of a transverse section, a longitudinal one, you will then see the simple leaves inserted at the margins of the section, and be able to recognise how the central strands of tissue, or vascular bundles, as they are called, pass down from each leaf and form a connected skeleton through the whole shoot, by inserting themselves upon that vascular cylinder which I have already pointed out to you as being so obviously seen in the centre of the transverse section. The skeleton thus disposed is embedded in a bulky mass of ground tissue. This will give you an idea of the main points of construction of the shoot. Furthermore, we must bear in mind that the central cylinder is of rather complex construction, being composed of two different tissues, the wood and the bast. The tissue of the wood occupies in the transverse section a somewhat irregular outline, being disposed in the form of longitudinal plates which are more or less distinct from one another. The space between them is filled in with the bast, but it would be going too far into detail to describe these matters more minutely.

Let us pass on now, for a few moments, to the roots of the *Lycopodium*. As I have already indicated, the roots bifurcate in a dichotomous manner. If you cut a transverse section of them you would find that it appears as rather a simple edition of what you have already seen in the case of the stem; but if you go on to the roots which are of smaller size, and examine their structure, you would see that it is very much simpler. Not only would the size of these roots be much smaller, but the central cylinder would be much simpler; and instead of the development of wood beginning, as is the case in these older roots, from a number of points—the roots being called *polyarch*—in these simpler cases the development would only start from one point, and the wood will appear as a simple strand surrounded by a layer of bast. This arrangement, which is described as *monarch*, will come into comparison with some of the geological forms which we shall have to consider later on. We may now go on to examine the organs of reproduction. It is a matter of common notoriety that there are produced at a certain period branches which are terminated by two or three or more strobili or cones. These are similar to those which are borne upon the specimen of *Lycopodium annotinum* which were handed round. They are specialised branches, and they bear, in addition

to the leaves, certain capsules which we term *sporangia*, in which are produced a number of small roundish bodies or spores. The *Lycopodiums* produce these in very large numbers, and, all these spores of *Lycopodium* being alike, the plants are termed *homosporous*. You may assume that from some of these spores new plants can be produced, as is the case in ferns. Though many investigators have attempted this, it is only in the rarest cases that success has attended their efforts, and for very many years the mode of propagation of *Lycopodiums* was a closed book. It is only by careful investigation in comparatively recent years that we have gained some knowledge of how the *Lycopodiums* reproduce themselves; but, as for the purpose of comparison with geological forms the details of reproduction will not come in, I will not carry you beyond this point.

We may now consider one or two forms allied to *Lycopodium*. Among gardeners *Selaginella* commonly goes under the name of *Lycopodium*, and in the books of forty years ago it was included in the genus *Lycopodium*. The general habit of the plants is not unlike that of some of the forms we have been considering, but when we come to examine the strobili we find that there are *sporangia* of two different sorts. Some of them produce a small number of spores of a relatively large size, while in the others are produced a very large number of smaller spores. Thus *Selaginella* differs from *Lycopodium* in this main point—that while *Lycopodium* is a *homosporous* type, *Selaginella* is *heterosporous*, there being an obvious distinction between the smaller male and the larger female spores. There are between 300 and 400 species of the genus *Selaginella*. They are of more general occurrence than the species of *Lycopodium*, and in the forests of Brazil, and the tropics generally, they form a prominent part of the undergrowth. There still remain several distinct genera for our consideration, but they are plants which are of relatively restricted distribution, and some of them are of very small size. The most interesting I have to put before you is *Phylloglossum*, which is nearly allied to *Lycopodium* itself. It is a plant which grows in the southern part of Australia and in New Zealand. It is found on mud flats, and attains a height of about  $1\frac{1}{2}$  inches. You find it appearing as a small structure with about half-a-dozen acicular leaves, sometimes only a single leaf, while on some plants you may find a small strobilus borne upon an elongated peduncle. You have here, in fact, a very small plant of the *Lycopodium* type in which the organs of reproduction corre-

spond very closely to those of *Lycopodium*. We have here in this pot what I believe are the only growing specimens of this plant in Europe, and we owe them to the kindness of Baron von Müller of Melbourne. I may next mention the plant *Psilotum triquetrum*. It is commonly grown in botanic gardens, because it is a peculiar type; but I can hardly stop to describe it. I will merely state that in one respect it is peculiar and interesting. It grows best in humus, or decaying vegetable matter, and it seems probable that this point is a somewhat important one in its physiological history. It seems to me it is not at all impossible that there may be some special relation between the humus and the growth of the plant itself. That is so with another plant of this class, of which there are living specimens at Kew and in Edinburgh, but not here. It is called *Tmesipteris*, and grows on the stems of tree ferns, more especially on the decaying portions. I mention this fact because among the geological forms what must have been a decaying mass of vegetable matter is often penetrated through and through by the small stigmarian roots. So the same habit which we recognise in such plants as *Tmesipteris* and *Psilotum* was also a habit in certain of these geological forms. Lastly, I will mention the native plant, *Isoetes*. It grows at the bottom of fresh-water lakes, especially those of very old standing, and it appears rooted in the substratum. It consists of a very short stalk covered by a number of long leaves, which bear on their faces the sporangia. At present it is a question under discussion as to whether the true position of *Isoetes* is in the family of the club mosses or the ferns, and good grounds have been put forward for entertaining the alternative view that it is not nearly related to the Lycopods, but that its true position may rather be with the ferns, of which it may be regarded as a degenerate type which assumed the aquatic habit. I am not inclined at present to express an opinion on the matter, but there is certainly a good deal to be said for this view.

I have now given a very brief sketch of the main representatives of the living club mosses, but before going on to consider the geological forms related to them, there is one further point which I should wish to bring before you. In the development of the young embryonic plant the first root appears in *Lycopodium* as an outgrowth from the superficial tissues of the embryo. Now we all know that one of the main features of the roots of the higher plants is that they originate endogenously, that is to say not from

the tissues of the outer surface, but from deeply-seated tissues, and that they push their way through the external tissues. They are of endogenous origin, and originate not from the external surface, but below it; but in these embryos of the modern Lycopods you find that the root does not originate endogenously, but the first root is produced from the external tissues, and it is actually exogenous. Professor Williamson, of Manchester, has been able to demonstrate that in the case of *Stigmaria*, in which the roots are present in very large numbers, the origin of the roots must have been exogenous, and so must agree with the modern *Lycopodium* and *Phylloglossum*.

We will now consider the series of geological forms which fall into relation with these modern forms. People in and about Glasgow are no doubt familiar with some of the main points of the remarkable series of plants which belonged to the series of club mosses in geological times. These drawings, which have been very kindly lent to me by Mr. D. C. Glen, represent the extraordinary grove of fossil trees, as they are called, with which most of you will be perfectly familiar in the Victoria Park at Whiteinch, and which have been covered and protected for the enjoyment and instruction of the public, by a house which was recently erected. Now, on looking at these you will see from their butts, which remain in their natural position, that they must have been of great size, their prostrate forms extending to a very considerable length. These are the butts or stocks of trees which extended to a length of something like 120 feet, and, comparing these with the pigmy forms which we have been considering, you will see how greatly the ancient forms outstripped those of modern times. We shall now refer to the construction of these *Lepidodendrons*, and compare them with the small forms we have now living. Many of the details of the internal construction of these plants are still preserved to us, and we can in many cases cut sections of the preserved remains and examine them under a microscope with almost the same precision as sections of the tissues of modern plants.

On the table there is laid a fine series of sections which I have acquired through Professor Williamson. But before entering upon the detailed study of these, we may first try and gain a general idea of the nature of these plants from their external characteristics. The trunk, as we have already seen, was a body of very considerable diameter attached to a root system which is

the familiar fossil which passes under the name *Stigmaria*. The trunks bear on their external surface the scars which indicate the places where the leaves were attached to them; and there is one point which we recognise at once as a difference between these *Lepidodendrons* and the modern *Lycopods*. The latter hold their leaves and do not drop them; but it appears to have been the rule that the *Lepidodendrons* and also the allied plants which pass under the name of *Sigillaria* dropped their leaves in the same way as the deciduous trees of the present day. At any rate, we find the external surface covered with scars which can only be the points of attachment of the leaves. Each scar is surrounded by a diamond-shaped area, which is the basal cushion of the leaf, and the whole external surface of the stem is covered by these cushions, as is the case with many of the modern *Coniferæ*. Looking at the actual surface of the scar you see three points, one rather long, a transverse one, and two dots—one on either side. You may be disposed to think from this that there were three vascular bundles running up the leaf, but an examination of the internal structure shows that there was only a single bundle, as in our modern *Lycopods*, running up into the leaf, and this is represented by the central scar where the vascular bundle broke away. It is not yet decided what the lateral dots are, but it is suggested that they may be some small resin cavities, such as are found in certain allied plants. At all events, the opinion is generally held that they are not vascular bundles. Below the point where the leaf is inserted on the cushion there are frequently two small dots, and it is an interesting question what these small dots may be. It has been suggested that they may be the points of origin of roots, but they occur high up on the stem, and not where one would expect roots to be. Another suggestion is that they may be lenticels, similar in nature to those found generally on tree ferns. Such lenticels, if they existed, would come out in casts of the surface as rounded excrescences, in very much the same way as these small dots on the *Lepidodendron* scar actually are. As to the nature of the foliage, we have a series of specimens here which will well suffice to illustrate its character. You will be able to see in certain of these that the leaves are of a subulate form, very much like those which we see in the common *Lycopods* of to-day. They are pointed and simple, and, as far as we understand them, they were traversed longitudinally by a single vascular bundle in the same way as in the leaves of the modern

types. As to the mode of branching of the axis, we have already seen that in the modern forms the branching is in some cases dichotomous, and in this specimen you will see an example of dichotomy of a similar nature. Passing on, in the course of this rather general description, to the base of these large plants, it is seen that the root system is of a peculiarly regular and definite type. This is well exemplified in the photograph of that magnificent specimen which was found in a quarry near Bradford, and is now lodged in the museum at the Owens College, Manchester. In the first instance, there are four large roots. If you were to examine such a specimen from underneath you would see that from the centre of the butt there are four large roots which obviously form two pairs—two of these being set rather lower down than the other two. As a rule, immediately after these main roots leave the stock they bifurcate, and the bifurcation is repeated once or twice more. In examining the surface of these roots, which appear with almost diagrammatic regularity, you see that they are covered by roundish marks, which are a characteristic of the fossil so familiar to everybody under the name of *Stigmaria*. It was long thought to be a distinct and separate organism, but it has been found possible in various specimens to trace the trunks upwards from the stigmarian roots, and to prove that above they bore the characteristic lepidodendron scars, which would be sufficient to demonstrate that these stigmaria roots are not distinct organisms but merely the basal portion of the *Lepidodendron* plant. It has been described how, after repeated bifurcations, these large stigmaria roots end at times in a rather blunt apex. It would lead me too far to discuss this at length, but there are various views held upon this point.

I have yet to describe what is the nature of these circular scars which cover the stigmaria root externally. Their appearance is so well known that I need hardly stop to describe them. They are the points of origin of rootlets which radiate outwards from the main root of the stock in all directions. Occasionally they bifurcate, but this is rather uncommon, though it has been actually observed, so that in this respect the rootlets of the *Stigmaria* resemble the rootlets of the modern *Lycopodiums*. An examination of sections through the point of attachment of the rootlets shows that the cortex of the main root is continuous with that of the lateral rootlet. This observation would point to the conclusion that their origin is exogenous—a point of peculiar interest,

since it has recently been shown that this is the mode of origin of the roots of the embryos of both *Lycopodium* and *Phylloglossum*. Count Solms has recently given an interesting description of the relation of the rootlets to the apex of the main root. He finds those near to the extreme tip, instead of spreading at right angles to the main root, assume a more and more oblique position the nearer they are to its extreme apex, holding, in fact, the same position with regard to it as do the leaves to the axis in the bud of an ordinary tree. Such an arrangement of young roots is unknown among modern forms, and if this discovery be confirmed we shall have on these stigmata roots an arrangement of rootlets absolutely unique according to our present knowledge.

We shall now go on to consider the internal structure. We are quite familiar with the main point, that among our living plants the larger the plant the greater the need for mechanical as well as physiological support for the organs which are produced. And the need for that support is met in the case of our ordinary trees by a process of secondary thickening, or the formation of new tissues, by means of which the stock may ultimately attain a considerable size. Now, in these plants you would reasonably expect to find this same process of secondary growth as that which we see in our modern trees. But when you come to look back down the series of living forms of *Lycopods*, it is seen that there is only a formation of tissues once for all: there is no secondary growth. They do not require that secondary thickening, and do not show it. The same was probably the case, for certain of the carboniferous forms, such as *Lepidodendron Harcourtii*. But when you come to examine certain of the large stems it is found that they underwent a process of secondary thickening. The most conspicuous case is that of the *Lepidodendron* stems, found extremely well preserved in the Island of Arran some years ago. In cutting the stock of these towards the base in the transverse sections there was found internally buried in a large mass of more or less disorganised cortex a central vascular mass. Now in this specimen, lent me by Mr. Glen, you may see this central cylinder not in a central position but somewhat excentric, and it will give you an idea of the relatively small size of the woody cylinder present in these stems. This woody cylinder, which is relatively small as compared with the whole bulk of the stock, consists of two parts, which can be readily recognised in the transverse section, and this character was the origin of the

name "diploxylon," which was in former times applied to these stems. There is to be recognised a central part which corresponds roughly to that primary wood which you find in our modern *Lycopodiums*; but over and above it, there is a secondary formation which is more like to the secondary wood of the pine than to anything which appears in the modern *Lycopodiums*. It is obviously a result of secondary growth, just as the wood of the pine is. Outside this was the bulky cortex; and the cortex itself shows in its external portions secondary growth and increase in bulk, such as is not found in the modern types. If you look among all our living vascular cryptogams and try to find such cases of secondary growth, there are only one or two which illustrate it at all, and that only in a small degree. The plant *Isoetes* is the chief representative of it, but there the secondary growth only attains to a relatively small size as compared with what we see in the larger *Lepidodendrons*. There are two very fine sections here which illustrate the secondary growth and increase in the wood, and also the cortex in the *Lepidodendron* stem. Passing on now to the roots, as regards the main stigmata trunks, just as in the case of the thick stem, there is a very bulky cortex which underwent a secondary increase, while the vascular cylinder is relatively small, as in the stem, but also was subject to a secondary growth.

Referring now to the details of the rootlets themselves, it is here that we obtain, chiefly from the labours of Professor Williamson, who has specially interested himself in the microscopical structure of these plants, a knowledge of the stigmata rootlets. He has been able, by careful examination, to trace the development of these roots from the very earliest stages to the mature condition, and his work upon them reminds one more of investigations on modern plants than of the organisms of so remote a period as the carboniferous. He has found that these roots of the *Stigmata* are monarch, as in the case of the small roots of the modern *Lycopodium*. Of course, you cannot expect that all the tissues will be preserved; the phloem is usually very incomplete, but the woody tissues are represented often with great perfection.

Now, as to the reproductive organs of the *Lepidodendrons*, these appear as strobili, or cones, of a somewhat similar nature to those which we see in the *Lycopodium clavatum*, and pass under the name of *Lepidostrobus*. These were borne upon special branches of the *Lepidodendron*, and after attaining maturity they were shed,

Having now indicated the position in the general system which, according to our present views, the Lycopods hold, we may go on to consider those forms of this family which we have now living upon the earth ; and, as is usually the case in lecturing, it would be well to start with some forms familiar to us all. I have therefore taken care to obtain a considerable supply of our three commonest species of *Lycopodium*, with a view to your making yourselves acquainted with the main characteristics of these three species, though no doubt they are familiar to many of you already. Taking first *Lycopodium Selago*, you have here a plant which has a somewhat massive axis, and upon that axis or stem there are inserted a large number of small leaves of a simple form. If you look at the axes themselves, and examine how they branch, you will see that there is a characteristic point to be recognised about them. To put it diagrammatically, the main axis grows up to a certain point and then branches off into two parts, which are precisely equivalent to one another. That is what we should call a "dichotomy," and I draw your attention at once to this dichotomous stem, because, though not universal for the club mosses, it is rather a characteristic feature. If you turn for a moment to this stag's-horn moss, as it is called, and examine the branching, you will see that it is not exactly dichotomous, and accordingly, though this dichotomous branching may be recognised frequently, it is not universal throughout the family. When we come to examine the geological forms, you will see that dichotomy is perhaps more distinct and stereotyped in them than in the modern ones. Then, further, if you examine the roots of any one of these species—and of course in the specimens dragged up as these have been you can hardly expect the root system to be very perfectly preserved,—you will be able to observe that there are in the roots, which arise from the lower parts of the stem, dichotomous branchings of a similar nature to that which I have alluded to in the axis.

As regards the simple form of the leaves, I would draw a comparison between these Lycopods and some of the common Coniferae. I have brought in a twig of *Thuja*, and you will see on it that simple type of leaf, with a rather broad basal cushion, which is characteristic of the Lycopods. The whole external surface of the stem may here be seen to be covered by these basal cushions, and this character may be clearly recognised in many of the geological forms. It is seen repeated in some, at all events, of

the coniferous trees ; and it is on such grounds as this, and also on the characters of the internal tissues, and of the reproductive organs, that we assign to the Coniferæ the position I have just stated.

I will now go on to point out one or two of the less familiar forms of the genus *Lycopodium*. Here is another species which is not so common, namely, *L. annotinum*. It is a native of this country, being found on some of the higher mountains of Scotland, and is present in considerable quantities in Norway and elsewhere. You would recognise the same characteristics here as in the other specimens, but in addition there are present upon this specimen large cone-like buds at the ends of the branches called strobili, or fruit-bearing branches. Our own native species are relatively small plants, but among the tropical forms there are some which are distinctly larger ; and I have brought from the University herbarium two specimens in order to illustrate those of the modern species which approach most nearly to the gigantic *Lycopods* which are so prominent among the flora of geological times. The first is practically a similar plant to *Lycopodium Selago*, but is much larger ; it is the species *Lycopodium phlegmaria*, which grows to the length of more than two feet. The strength of the axis is insufficient for supporting the whole weight of the head, which therefore has a drooping habit. This habit appears also to have been the characteristic of certain of the geological forms, and that conclusion is to be drawn partly from the actual form of the fossil remains, and partly from the fact that the stems are relatively small and of weak construction in comparison to the bulk of the heads which they had to support. This, then, will suffice to give us some idea of the nature of the comparatively small forms belonging to the genus *Lycopodium*, or club mosses, which now live upon the earth.

We may pass on to consider, for a few moments, certain points of the internal structure of these, because we are tolerably well-informed of the internal structure of some of the geological forms, and we shall require certain facts regarding the internal structure of the modern forms for comparison with the ancient. If you make a transverse section through the stem of *L. clavatum* the section will appear circular, with occasional projections here and there which correspond to the position of the leaves ; and in each of these you will see a small round patch of tissue, which is a vascular strand. This passes out from the leaf longitudinally up to its tip. Smaller strands may be seen dotted here and there at

points nearer the centre, while the centre of the transverse section would be occupied by a large strand of tissue, called the vascular cylinder. Supposing you cut now, instead of a transverse section, a longitudinal one, you will then see the simple leaves inserted at the margins of the section, and be able to recognise how the central strands of tissue, or vascular bundles, as they are called, pass down from each leaf and form a connected skeleton through the whole shoot, by inserting themselves upon that vascular cylinder which I have already pointed out to you as being so obviously seen in the centre of the transverse section. The skeleton thus disposed is embedded in a bulky mass of ground tissue. This will give you an idea of the main points of construction of the shoot. Furthermore, we must bear in mind that the central cylinder is of rather complex construction, being composed of two different tissues, the wood and the bast. The tissue of the wood occupies in the transverse section a somewhat irregular outline, being disposed in the form of longitudinal plates which are more or less distinct from one another. The space between them is filled in with the bast, but it would be going too far into detail to describe these matters more minutely.

Let us pass on now, for a few moments, to the roots of the *Lycopodium*. As I have already indicated, the roots bifurcate in a dichotomous manner. If you cut a transverse section of them you would find that it appears as rather a simple edition of what you have already seen in the case of the stem; but if you go on to the roots which are of smaller size, and examine their structure, you would see that it is very much simpler. Not only would the size of these roots be much smaller, but the central cylinder would be much simpler; and instead of the development of wood beginning, as is the case in these older roots, from a number of points—the roots being called *polyarch*—in these simpler cases the development would only start from one point, and the wood will appear as a simple strand surrounded by a layer of bast. This arrangement, which is described as *monarch*, will come into comparison with some of the geological forms which we shall have to consider later on. We may now go on to examine the organs of reproduction. It is a matter of common notoriety that there are produced at a certain period branches which are terminated by two or three or more strobili or cones. These are similar to those which are borne upon the specimen of *Lycopodium annotinum* which were handed round. They are specialised branches, and they bear, in addition

to the leaves, certain capsules which we term *sporangia*, in which are produced a number of small roundish bodies or spores. The *Lycopodiums* produce these in very large numbers, and, all these spores of *Lycopodium* being alike, the plants are termed *homosporous*. You may assume that from some of these spores new plants can be produced, as is the case in ferns. Though many investigators have attempted this, it is only in the rarest cases that success has attended their efforts, and for very many years the mode of propagation of *Lycopodiums* was a closed book. It is only by careful investigation in comparatively recent years that we have gained some knowledge of how the *Lycopodiums* reproduce themselves; but, as for the purpose of comparison with geological forms the details of reproduction will not come in, I will not carry you beyond this point.

We may now consider one or two forms allied to *Lycopodium*. Among gardeners *Selaginella* commonly goes under the name of *Lycopodium*, and in the books of forty years ago it was included in the genus *Lycopodium*. The general habit of the plants is not unlike that of some of the forms we have been considering, but when we come to examine the strobili we find that there are *sporangia* of two different sorts. Some of them produce a small number of spores of a relatively large size, while in the others are produced a very large number of smaller spores. Thus *Selaginella* differs from *Lycopodium* in this main point—that while *Lycopodium* is a *homosporous* type, *Selaginella* is *heterosporous*, there being an obvious distinction between the smaller male and the larger female spores. There are between 300 and 400 species of the genus *Selaginella*. They are of more general occurrence than the species of *Lycopodium*, and in the forests of Brazil, and the tropics generally, they form a prominent part of the undergrowth. There still remain several distinct genera for our consideration, but they are plants which are of relatively restricted distribution, and some of them are of very small size. The most interesting I have to put before you is *Phylloglossum*, which is nearly allied to *Lycopodium* itself. It is a plant which grows in the southern part of Australia and in New Zealand. It is found on mud flats, and attains a height of about  $1\frac{1}{2}$  inches. You find it appearing as a small structure with about half-a-dozen acicular leaves, sometimes only a single leaf, while on some plants you may find a small strobilus borne upon an elongated peduncle. You have here, in fact, a very small plant of the *Lycopodium* type in which the organs of reproduction corre-

spond very closely to those of *Lycopodium*. We have here in this pot what I believe are the only growing specimens of this plant in Europe, and we owe them to the kindness of Baron von Müller of Melbourne. I may next mention the plant *Psilotum triquetrum*. It is commonly grown in botanic gardens, because it is a peculiar type; but I can hardly stop to describe it. I will merely state that in one respect it is peculiar and interesting. It grows best in humus, or decaying vegetable matter, and it seems probable that this point is a somewhat important one in its physiological history. It seems to me it is not at all impossible that there may be some special relation between the humus and the growth of the plant itself. That is so with another plant of this class, of which there are living specimens at Kew and in Edinburgh, but not here. It is called *Tmesipteris*, and grows on the stems of tree ferns, more especially on the decaying portions. I mention this fact because among the geological forms what must have been a decaying mass of vegetable matter is often penetrated through and through by the small stigmarian roots. So the same habit which we recognise in such plants as *Tmesipteris* and *Psilotum* was also a habit in certain of these geological forms. Lastly, I will mention the native plant, *Isoetes*. It grows at the bottom of fresh-water lakes, especially those of very old standing, and it appears rooted in the substratum. It consists of a very short stalk covered by a number of long leaves, which bear on their faces the sporangia. At present it is a question under discussion as to whether the true position of *Isoetes* is in the family of the club mosses or the ferns, and good grounds have been put forward for entertaining the alternative view that it is not nearly related to the *Lycopods*, but that its true position may rather be with the ferns, of which it may be regarded as a degenerate type which assumed the aquatic habit. I am not inclined at present to express an opinion on the matter, but there is certainly a good deal to be said for this view.

I have now given a very brief sketch of the main representatives of the living club mosses, but before going on to consider the geological forms related to them, there is one further point which I should wish to bring before you. In the development of the young embryonic plant the first root appears in *Lycopodium* as an outgrowth from the superficial tissues of the embryo. Now we all know that one of the main features of the roots of the higher plants is that they originate endogenously, that is to say not from

the tissues of the outer surface, but from deeply-seated tissues, and that they push their way through the external tissues. They are of endogenous origin, and originate not from the external surface, but below it; but in these embryos of the modern Lycopods you find that the root does not originate endogenously, but the first root is produced from the external tissues, and it is actually exogenous. Professor Williamson, of Manchester, has been able to demonstrate that in the case of *Stigmaria*, in which the roots are present in very large numbers, the origin of the roots must have been exogenous, and so must agree with the modern *Lycopodium* and *Phylloglossum*.

We will now consider the series of geological forms which fall into relation with these modern forms. People in and about Glasgow are no doubt familiar with some of the main points of the remarkable series of plants which belonged to the series of club mosses in geological times. These drawings, which have been very kindly lent to me by Mr. D. C. Glen, represent the extraordinary grove of fossil trees, as they are called, with which most of you will be perfectly familiar in the Victoria Park at Whiteinch, and which have been covered and protected for the enjoyment and instruction of the public, by a house which was recently erected. Now, on looking at these you will see from their butts, which remain in their natural position, that they must have been of great size, their prostrate forms extending to a very considerable length. These are the butts or stocks of trees which extended to a length of something like 120 feet, and, comparing these with the pigmy forms which we have been considering, you will see how greatly the ancient forms outstripped those of modern times. We shall now refer to the construction of these *Lepidodendrons*, and compare them with the small forms we have now living. Many of the details of the internal construction of these plants are still preserved to us, and we can in many cases cut sections of the preserved remains and examine them under a microscope with almost the same precision as sections of the tissues of modern plants.

On the table there is laid a fine series of sections which I have acquired through Professor Williamson. But before entering upon the detailed study of these, we may first try and gain a general idea of the nature of these plants from their external characteristics. The trunk, as we have already seen, was a body of very considerable diameter attached to a root system which is

the familiar fossil which passes under the name *Stigmaria*. The trunks bear on their external surface the scars which indicate the places where the leaves were attached to them; and there is one point which we recognise at once as a difference between these *Lepidodendrons* and the modern *Lycopods*. The latter hold their leaves and do not drop them; but it appears to have been the rule that the *Lepidodendrons* and also the allied plants which pass under the name of *Sigillaria* dropped their leaves in the same way as the deciduous trees of the present day. At any rate, we find the external surface covered with scars which can only be the points of attachment of the leaves. Each scar is surrounded by a diamond-shaped area, which is the basal cushion of the leaf, and the whole external surface of the stem is covered by these cushions, as is the case with many of the modern *Coniferæ*. Looking at the actual surface of the scar you see three points, one rather long, a transverse one, and two dots—one on either side. You may be disposed to think from this that there were three vascular bundles running up the leaf, but an examination of the internal structure shows that there was only a single bundle, as in our modern *Lycopods*, running up into the leaf, and this is represented by the central scar where the vascular bundle broke away. It is not yet decided what the lateral dots are, but it is suggested that they may be some small resin cavities, such as are found in certain allied plants. At all events, the opinion is generally held that they are not vascular bundles. Below the point where the leaf is inserted on the cushion there are frequently two small dots, and it is an interesting question what these small dots may be. It has been suggested that they may be the points of origin of roots, but they occur high up on the stem, and not where one would expect roots to be. Another suggestion is that they may be lenticels, similar in nature to those found generally on tree ferns. Such lenticels, if they existed, would come out in casts of the surface as rounded excrescences, in very much the same way as these small dots on the *Lepidodendron* scar actually are. As to the nature of the foliage, we have a series of specimens here which will well suffice to illustrate its character. You will be able to see in certain of these that the leaves are of a subulate form, very much like those which we see in the common *Lycopods* of to-day. They are pointed and simple, and, as far as we understand them, they were traversed longitudinally by a single vascular bundle in the same way as in the leaves of the modern

types. As to the mode of branching of the axis, we have already seen that in the modern forms the branching is in some cases dichotomous, and in this specimen you will see an example of dichotomy of a similar nature. Passing on, in the course of this rather general description, to the base of these large plants, it is seen that the root system is of a peculiarly regular and definite type. This is well exemplified in the photograph of that magnificent specimen which was found in a quarry near Bradford, and is now lodged in the museum at the Owens College, Manchester. In the first instance, there are four large roots. If you were to examine such a specimen from underneath you would see that from the centre of the butt there are four large roots which obviously form two pairs—two of these being set rather lower down than the other two. As a rule, immediately after these main roots leave the stock they bifurcate, and the bifurcation is repeated once or twice more. In examining the surface of these roots, which appear with almost diagrammatic regularity, you see that they are covered by roundish marks, which are a characteristic of the fossil so familiar to everybody under the name of *Stigmaria*. It was long thought to be a distinct and separate organism, but it has been found possible in various specimens to trace the trunks upwards from the stigmarian roots, and to prove that above they bore the characteristic lepidodendron scars, which would be sufficient to demonstrate that these stigmaria roots are not distinct organisms but merely the basal portion of the *Lepidodendron* plant. It has been described how, after repeated bifurcations, these large stigmaria roots end at times in a rather blunt apex. It would lead me too far to discuss this at length, but there are various views held upon this point.

I have yet to describe what is the nature of these circular scars which cover the stigmaria root externally. Their appearance is so well known that I need hardly stop to describe them. They are the points of origin of rootlets which radiate outwards from the main root of the stock in all directions. Occasionally they bifurcate, but this is rather uncommon, though it has been actually observed, so that in this respect the rootlets of the *Stigmaria* resemble the rootlets of the modern *Lycopodiums*. An examination of sections through the point of attachment of the rootlets shows that the cortex of the main root is continuous with that of the lateral rootlet. This observation would point to the conclusion that their origin is exogenous—a point of peculiar interest,

since it has recently been shown that this is the mode of origin of the roots of the embryos of both *Lycopodium* and *Phylloglossum*. Count Solms has recently given an interesting description of the relation of the rootlets to the apex of the main root. He finds those near to the extreme tip, instead of spreading at right angles to the main root, assume a more and more oblique position the nearer they are to its extreme apex, holding, in fact, the same position with regard to it as do the leaves to the axis in the bud of an ordinary tree. Such an arrangement of young roots is unknown among modern forms, and if this discovery be confirmed we shall have on these stigmaria roots an arrangement of rootlets absolutely unique according to our present knowledge.

We shall now go on to consider the internal structure. We are quite familiar with the main point, that among our living plants the larger the plant the greater the need for mechanical as well as physiological support for the organs which are produced. And the need for that support is met in the case of our ordinary trees by a process of secondary thickening, or the formation of new tissues, by means of which the stock may ultimately attain a considerable size. Now, in these plants you would reasonably expect to find this same process of secondary growth as that which we see in our modern trees. But when you come to look back down the series of living forms of Lycopods, it is seen that there is only a formation of tissues once for all: there is no secondary growth. They do not require that secondary thickening, and do not show it. The same was probably the case, for certain of the carboniferous forms, such as *Lepidodendron Harcourtii*. But when you come to examine certain of the large stems it is found that they underwent a process of secondary thickening. The most conspicuous case is that of the *Lepidodendron* stems, found extremely well preserved in the Island of Arran some years ago. In cutting the stock of these towards the base in the transverse sections there was found internally buried in a large mass of more or less disorganised cortex a central vascular mass. Now in this specimen, lent me by Mr. Glen, you may see this central cylinder not in a central position but somewhat excentric, and it will give you an idea of the relatively small size of the woody cylinder present in these stems. This woody cylinder, which is relatively small as compared with the whole bulk of the stock, consists of two parts, which can be readily recognised in the transverse section, and this character was the origin of the

name "diploxylon," which was in former times applied to these stems. There is to be recognised a central part which corresponds roughly to that primary wood which you find in our modern *Lycopodiums*; but over and above it, there is a secondary formation which is more like to the secondary wood of the pine than to anything which appears in the modern *Lycopodiums*. It is obviously a result of secondary growth, just as the wood of the pine is. Outside this was the bulky cortex; and the cortex itself shows in its external portions secondary growth and increase in bulk, such as is not found in the modern types. If you look among all our living vascular cryptogams and try to find such cases of secondary growth, there are only one or two which illustrate it at all, and that only in a small degree. The plant *Isoetes* is the chief representative of it, but there the secondary growth only attains to a relatively small size as compared with what we see in the larger *Lepidodendrons*. There are two very fine sections here which illustrate the secondary growth and increase in the wood, and also the cortex in the *Lepidodendron* stem. Passing on now to the roots, as regards the main stigmata trunks, just as in the case of the thick stem, there is a very bulky cortex which underwent a secondary increase, while the vascular cylinder is relatively small, as in the stem, but also was subject to a secondary growth.

Referring now to the details of the rootlets themselves, it is here that we obtain, chiefly from the labours of Professor Williamson, who has specially interested himself in the microscopical structure of these plants, a knowledge of the stigmata rootlets. He has been able, by careful examination, to trace the development of these roots from the very earliest stages to the mature condition, and his work upon them reminds one more of investigations on modern plants than of the organisms of so remote a period as the carboniferous. He has found that these roots of the *Stigmata* are monarch, as in the case of the small roots of the modern *Lycopodium*. Of course, you cannot expect that all the tissues will be preserved; the phloem is usually very incomplete, but the woody tissues are represented often with great perfection.

Now, as to the reproductive organs of the *Lepidodendrons*, these appear as strobili, or cones, of a somewhat similar nature to those which we see in the *Lycopodium clavatum*, and pass under the name of *Lepidostrobus*. These were borne upon special branches of the *Lepidodendron*, and after attaining maturity they were shed,

leaving behind a scar or boss where each was previously attached. Such branches bearing these bosses were long known under the name of *Halonia*, and it is only recently that the connection of these with *Lepidodendron* has been distinctly proved. A specimen preserved in the Leeds Museum shows the connection conclusively, for in the upper parts of it the axes are distinctly *halonial*, while the lower part shows the characteristic scars of *Lepidodendron*. Though similar to the strobili of our modern *Lycopodium* in their general character and construction, in size the *Lepidostrobus* exceeded them vastly, and among the fossil remains may be found various types from the size of a hazel nut to a foot-and-a-half in length. You will see here some specimens from the Hunterian Museum which show the external characteristics of the *Lepidostrobus* extremely well. The arrangement of the leaves can be recognised in these, and was the subject of a detailed study by my predecessor, Professor Dickson. When you come to examine the well-preserved examples of these cones, you will find that there is a central axis which bears, radiating from it, a large number of leaves, and I have here a transverse section from one of these strobili which will show the internal vascular arrangement of the axis, together with the spore-bearing leaves which surround it. When you examine the strobili in longitudinal section, the sporangium-producing leaf is of a form turned up at its extreme tip, and bearing on its upper surface a single sporangium. The sporangia are frequently found very well preserved. When viewed from above, the outline of the sporangia would be found to be not unlike that of the modern *Selaginella* or *Lycopodium*, though its form was more elongated. Thus, even in the details of form of the sporangia, there are points of similarity with the modern forms. When you come to examine the nature of the spores it will be found in some cases that the spores are all of equal size. Thus, some of the strobili are homosporous, just as in the case of the modern *Lycopodiums*. But in cases recently described it has been shown that there are two different forms of spore in the same strobilus—large female spores, and comparatively small male ones. Some of the spores shown by Professor Williamson are very similar in appearance to those of *Selaginella* itself. The presence of these spores may be readily detected in sections from the Halifax coal, and you may see, even with a simple lens, in the sections handed round, numerous roundish, transparent objects, which are obviously macrospores, similar to those of *Selaginella*. It may be thought

that I am rash in stating that these are spores of *Lepidodendrons*, but recently Professor Williamson has found these coal spores within lepidodendroid sporangia, so that we are justified in recognising them as belonging to the forms we have been considering.

I am well aware that what I have now said is but a slight sketch of the known facts; many details which would have been interesting have been omitted; and the whole subject has been treated in a dogmatic rather than a critical style. I have not aimed at addressing specialists, but my object has been rather to summarise the most important facts in a manner suited to a general audience. More especially it has been my object to draw comparisons between the living and the fossil forms, and to point out in what respects they resemble or differ from one another. In fact, the subject has been approached rather from the point of view of the student of the comparative morphology of plants than from that of the geologist. And our chief results are these:—That while the *Lepidodendrons*, which varied among themselves to a considerable extent as regards details, correspond in their most important characters to the *Lycopodium* of the present day, they differed greatly from them in certain respects. Of these, the most notable are (1) size, (2) presence of secondary thickening, (3) sexual differentiation. To the botanist, mere size of the individual is not a very important character, but when we compare the present club mosses with the *Lepidodendrons*, which grew to a length of some 120 feet, the difference cannot fail to be striking. The presence of a secondary formation of tissues in the stem is a natural consequence of the great size; however, certain palæophytologists of the French school laid it down as a dogma that stems which showed a secondary increase must belong to the *Gymnosperms* or *Dicotyledons*; but we now know that a secondary increase of tissues is a character of but little systematic value; it is to be regarded as a response to mechanical and physiological needs, which may appear independently in quite distinct families of plants. It is seen in one form or another in *Algæ*, in each of the three phyla of Vascular Cryptogams, in *Gymnosperms*, in *Monocotyledons*, and *Dicotyledons*; and thus it has probably originated, as a parallel development, independently in families which are systematically quite distinct. The third point of difference between the *Lepidodendrons* and modern *Lycopodiums* is the sexual differentiation of larger, female, *macrospores*, from smaller, male, *microspores*. This finds its parallel in our modern

Selaginella, but on that ground it would hardly be fitting to associate the two closely in the system. This differentiation of spores so as to result in the heterosporous condition is also a phenomenon which has probably occurred repeatedly, and as a parallel development in families systematically distinct. We see it in all the three phyla of the Vascular Cryptogams, in Ferns, Equiseta, and Lycopods, and it is quite possible that it may have originated repeatedly even within the limits of one phylum. Thus, we become familiar with the idea of parallel but distinct developments taking place in the course of evolution, and this is perhaps the point which, to the botanist, is the most important result of the examination of the plants of early geological periods. It can hardly be expected that the study of palæophytology will ever result in filling in with any approach to completeness the great gaps in the history of evolution. At the present moment its most valuable contribution to the problem is that we receive from the study of fossil forms the proof that parallel developments have been more frequent than the mere study of living forms might lead us to believe.

XVI.—*On the Reclamation of Waste Lands in the Clyde Estuary, considered in relation to the Disposal of the Sewage of Glasgow.* By ALEXANDER FREW, C.E.

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[Read before the Architectural Section, 16th December, 1889.]

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(WITH MAP OF CLYDE ESTUARY.)

Two very important and apparently perplexing questions are at present being forced upon the attention of the citizens of Glasgow, and the public voice seems to be gaining strength in its demand that the authorities shall at once look these questions straight in the face, and make a real effort to solve them in a practical and satisfactory manner.

I say a real effort, because have there not been many partial efforts made in the direction of the solution of these questions, but all of which have attained their maximum when the stage of a report has been reached.

The questions to which we refer, and which are still waiting to be properly answered, are (1) What is to be done in regard to the disposal of the sewage of the City of Glasgow, and the purification of the River Clyde? and (2) What is to be done with the dredgings of the river?

In recent years the latter question has frequently cropped up in Parliament, with the result that an official Government inspection has been made into the disposal of the Clyde dredgings, as at present carried on, and the effect of that system upon the lochs where these dredgings are deposited.

This inspection has been followed, like many other official inspections, by a report upon the alleged pollution of Loch Long and Loch Goil; but it yet remains to be seen what action the Government will take in the matter, if any.

The sewage question has formed the subject both of official and unofficial reports and discussions during the last twenty years or more, and in spite of all these, and also of the numerous and lengthy effusions on this subject with which the newspapers have

been burdened for years, this question remains unsolved; our noble river is filthy still, and it becomes blacker and fouler as each succeeding report comes forth, and our sewers and drains stink as they never stank before.

Some of these reports have been prepared by eminent men, and at considerable cost to the Corporation of Glasgow. The Town Council read the reports, laid them on the table, and afterwards took them to avizandum; and they have ever since remained in avizandum, wherever that may be.

Perhaps, on the whole, it is fortunate that such has been the course of procedure, and probably in the long run it will be ascertained that we have not lost anything, except the expense, through the delay in the adoption of one or other of the gigantic and costly schemes which have from time to time been brought before us.

I propose to add one more to the many contributions on this subject, not because I may have anything of importance to say which has not been said before, but rather in the hope that a lively and perhaps useful discussion will ensue among the members of this society, and that your deliberations may shed one ray of light, however dim, upon this dark though oft-considered question.

The present system of sewage disposal in Glasgow must of course be so familiar to you that it does not call for any lengthy description; but, to speak shortly, it amounts to this: The whole of the sewage is discharged into a very large settling pond known as the Harbour of Glasgow; after it has had time to settle in sufficient quantity, it is then lifted out again, removed in barges, and finally deposited in another settling pond known as Loch Long.

That is as short and truthful a description of the present system of sewage disposal in Glasgow as I am able to give, and probably when the extreme simplicity of the system is considered, any more elaborate description would be superfluous.

This delightfully primitive state of matters will most likely continue so long as we have divided authority—that is to say, so long as we have one authority in Glasgow, and about a dozen independent authorities on the outskirts of the city.

Apart from all other considerations, the settlement of the sewage question and the purification of the river point in a very decided manner to the necessity for annexation or amalgamation of the outside burghs and districts with the parent city in which they live, move, and have their being. None of the burghs can

afford, neither would it be judicious on their part if they could, to enter upon a sewage scheme of their own, and it would certainly be unwise on the part of Glasgow, single-handed, and without the co-operation of the burghs, and also of the Clyde Trustees, to enter upon a scheme involving such heavy responsibilities. Perhaps I speak strongly on this point, but if annexation or amalgamation is not to be an accomplished fact in the near future, at least let the Corporation of Glasgow and the burghs shake hands over this matter, for it affects them all alike.

At this point I propose to give a short account of, and to make a passing remark upon, some of the more important sewage schemes which have been suggested for Glasgow.

Sir John Hawkshaw, Sir Joseph Bazalgette, and Mr. Bateman all proposed to intercept the sewage of the city, and transfer it to the sea, at a greater or less distance down the firth, by means of an outfall sewer; and Mr. Bateman, in a subsequent scheme, proposed to convey the sewage to Dalmuir and Braehead, on the north and south sides of the river respectively; and at these places it was to be treated chemically, so as to permit of the clarified effluent flowing into the river. The sludge resulting from the chemical treatment was to be transported in barges to the sea, and there deposited.

Another scheme, of which we have lately heard much, is to divide the city into sewage districts, to construct precipitation and manure-manufacturing works in each district, and there to clarify the sewage according to one or other of the well-known chemical processes, and to dry, press, and grind the sludge into artificial manure in the hope of disposing of it at a profit.

The last scheme to which I will refer was recently proposed by Mr. Young, the Inspector of Cleansing in Glasgow.

That gentleman proposed to adopt a system of irrigation and filtration upon several thousands of acres of land lying to the south-west of the city—in fact, to institute a large sewage farm for Glasgow, similar to those farms which obtain at Croydon, near London, and at New Derby, near Liverpool.

The various schemes which have been proposed, and to some of which reference has just been made, are all more or less open to objection. It may seem presumptuous on my part to criticise the schemes and proposals of eminent men, such as the authors of some of these schemes undoubtedly are, and it has not been without considerable hesitation that I have come to the conclusion to do so.

Does it appear very far removed from absurdity seriously to propose the expenditure of a princely sum of money with no other object in view than the transfer of the sewage from Glasgow to some other place, and there discharge it into the firth or the sea without the slightest attempt to clarify or utilise the sewage? Does this proposal suggest any such improvement on the present bad system as to warrant any expenditure whatever, and does it not contain a recommendation to practice what may be termed corporate selfishness, by seeking to impose upon our neighbours a disagreeable and offensive burden of which we are longing to be relieved?

The subsequent proposal of Mr. Bateman, to clarify the sewage and transport the sludge to the sea in barges, is not a whit better than the former. In the one case the sewage was to be conducted to the sea in its crude state, while in the other it was to undergo an expensive process of treatment, and, after all, the residue was to be thrown into the sea.

In the divided-district scheme, which has been so diligently promoted by Mr. G. W. Muir, while expense would certainly be saved through a main outfall sewer not being required, it would, owing to the number of sewage works, be more costly to supervise and work than a concentrated scheme; and then it apparently cannot be, and has not yet been demonstrated, that, almost beyond the precincts of a chemist's laboratory, the pressed and ground sludge would find a market in such quantity, and at such a price, as to pay the cost of making it, or even to go far in minimising the loss.

Mr. Young's scheme of irrigation and filtration upon land is an adaptation of the system, if not invented, at least so ably applied and worked out, by Mr. Bailey Denton, civil engineer, in London. I consider that in this system, properly applied (for success depends largely on the method of application), will be found the practical and profitable solution of the sewage question for the great majority of towns and communities in this country.

Some years ago I had occasion professionally to make an inspection of many of the sewage works in England, including both those works where the sewage is precipitated and clarified chemically, and those where the system of irrigation and land filtration is practised. I then came to the conclusion, both from what came under my observation, and from a careful study of the results and cost of the different systems, that for all ordinary towns the system of purification and utilisation upon land is to be preferred to

that of chemical treatment. My chief reasons for forming that opinion were these, that in those works where the chemical system is practised,

- (1) The effluent is not so pure as in the case of the irrigation and filtration works ;
- (2) The sludge resulting from the precipitation by chemicals accumulates at the works steadily, and cannot be disposed of even for nothing ; and
- (3) The cost and maintenance of the works, instead of tending to produce a profit, are invariably in the opposite direction.

As has been already said, the system of irrigation and filtration upon land is probably the best suited for all ordinary towns, but as there are exceptions to every good rule, there is one here also. Glasgow is not an ordinary town, but a most extraordinary city, comprising in its sewage the waste products and refuse from all sorts and conditions of manufactories and public works, and it would, in my opinion, be found practically impossible to carry out Mr. Young's scheme successfully in Glasgow without, at great cost, making an attempt to classify the sewage of the city—that is to say, to separate the waste products and refuse of many of the public works from the purely domestic sewage. It has been claimed by the promoters of some of the schemes which we have just been criticising, that their own particular scheme surpasses all the others on account of its moderate cost ; but no matter how the question may ultimately come to be solved, Glasgow must look forward to a very large outlay in this department ; and I do not anticipate, taking one thing with another, that there will be much difference between the cost of any of the systems or schemes which may be proposed.

Pumping stations for the sewage of the lower levels of the city are incidental to all the schemes referred to, and to any scheme for Glasgow which could be named, with the exception perhaps of Captain Liernur's pneumatic system (which need not be considered) ; so also are main intercepting and outfall sewers, and purification works of one kind or another incidental to all the schemes alike. The only exception in this respect is Mr. Muir's scheme, which would not, as we have already stated, require an outfall main sewer, but also it would require pumping stations, intercepting sewers, and a considerable rearrangement of the existing sewers,

so as to convey the sewage to each of the works in the various districts contemplated in his scheme. The cost of a few miles of a main outfall sewer would not probably exceed the extra cost which would be involved in the substitution of, say, four separate sewage works in the city for one work outside of the city.

The restoration of the River Clyde to a state nearly approaching its pristine purity may be said to partake more of the æsthetical than the practical, and I do not think it can be proved either that the death-rate in Glasgow has been raised owing to the impure state of the river, or, consequently, that the death-rate could be reduced by the purification of the river. At the same time, it surely cannot be said of Glasgow that she is so eminently practical and utilitarian as not to be willing to pay for anything which partakes to a certain degree of the æsthetical. But the purification of the river is not entirely an æsthetical question, as those who, either through necessity or choice, live upon its banks or travel by steamer can testify. If the pollution of the river increases at the same rate at which it has increased within the past twenty years, it will soon become a very practical evil, and passenger traffic, already greatly diminished, will entirely cease.

We have great reason to be proud of our river, because by perseverance and skill it has been converted from a fordable stream into a magnificent water-way capable of carrying the largest vessels afloat, and of bearing on its way no mean share of the world's commerce ; but we have as great reason to be thoroughly ashamed of the offensive and filthy character of the water, and not until this has been remedied will we be in a position to point to our river, and say with righteous pride, " We have done this ! "

At the risk of digressing from the subject upon which I have engaged to address you, perhaps you will allow me to say that in the proper ventilation and flushing of the city sewers and private drains lies one of the true keys to the reduction of the death-rate. Unless I am greatly mistaken, there is not a single flushing apparatus in one of the public sewers of Glasgow, nor is there a proper system of ventilation. The trapping of all connections with the sewers is a proper provision to make in order to prevent, as far as possible, the gases in the main sewers from entering private drains, and so getting into the houses ; but why should gas be allowed to generate in the sewers, and even if allowed to generate to a certain extent, why should it not be thoroughly extracted from them ?

The Government of this country would just be as culpable as the Corporation of Glasgow are in this respect, if they were to permit a foreign foe to land upon the shore, and then after the landing had been successfully effected, to request the volunteers to retain the enemy at or near high-water mark.

The main sewers are constructed so as to carry off storm waters, and, consequently, during ordinary weather, they are much too large for the mere conveyance of the sewage. As the flood waters subside, there are portions of sewage matter left adhering to the sides of the sewers. These in a short time decompose and resolve into gases, and then the mischief is done. The occupants of the houses are at once brought into a position where they are liable, if so predisposed, to contract dangerous, insidious, and not infrequently fatal diseases, from which, in other circumstances, they might happily escape.

That is a branch of the sewage question which the Corporation should be bound to face with no delay, and all the more so that it can be solved without either very great trouble or expense; and, further, as long as the Corporation of Glasgow continue to neglect the rectification of this important defect in the sewage system of the city, they will be accounted morally, if not legally, responsible for the ill-health, ay! even for the death of many of the citizens.

But, to return to the subject with which we are more immediately connected, we have before us the following circumstances:—(1) The dredgings of the River Clyde, including with them the deposited sewage from the city, are at present deposited in Loch Long; and (2) admitting that the sewage should be kept out of the river, it follows that it must be clarified. These circumstances suggest the following questions, namely:—Is the depositing of the dredgings in Loch Long the right course to pursue in the circumstances? and what is the best and most useful way of disposing of the large quantity of sludge which will result from the precipitation of the sewage?

While I do not think that the depositing of the dredgings in Loch Long is the best course to pursue, I am at the same time inclined to believe that the pollution of Loch Long and Loch Goil is not due, to any great extent, to the deposit of the dredgings by the Clyde Trustees. The dredgings have been taken to Loch Long for nearly thirty years; and it was not until Mr. Bradlaugh, M.P., became enamoured of Scottish loch scenery, and until he was supported in his views, on this question, by another gentleman

from England who recently came to live in the neighbourhood, that any formal complaints were made about pollution in these lochs. I have lived on the bank of one of the lochs for three or four months of each of the last fifteen years, and I can honestly say that I have never seen anything which would justify one in attributing the pollution to the deposit of the dredgings.

Pollution of the lochs there most certainly was, and is, and I venture to say so, notwithstanding the fact that Dr. Frankland, an eminent authority on all such subjects, has recently reported that the waters of these lochs are very much purer than the water of the Atlantic Ocean. Perhaps the learned doctor drew his Atlantic sample from astern a large ocean steamer containing the population of a small town.

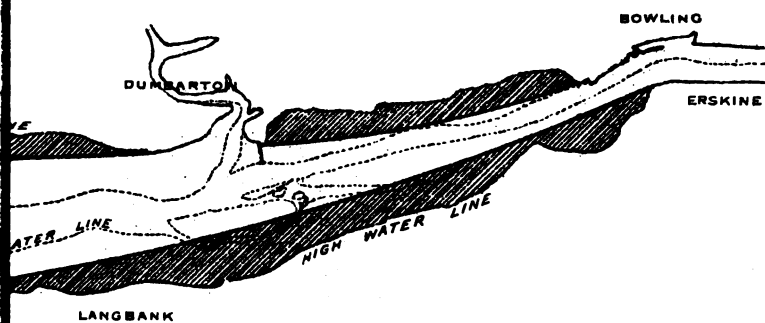
About two years ago it was the custom for a barge, laden with chemical refuse, regularly to deposit its cargo on the surface of Loch Long; but this objectionable practice has, fortunately, been discontinued. A large proportion of the pollution consists of soot and oily substances dropped from passing steamboats, and another part of it comes from the residents on the shores of the lochs.

The proposal which I intend to submit for your consideration neither contemplates the continuation of the deposit of the dredgings in Loch Long, nor the deposit of the sludge arising from the precipitated sewage in any part of the sea, as proposed by Mr. Bateman. A combination of the Clyde dredgings and the sludge from the sewage works would make rich agricultural land, and my proposal is that these materials should be devoted to that purpose in the manner afterwards to be described.

A great quantity of the fine arable land which is to be seen upon both banks of the river between Glasgow and Erskine consists of the Clyde dredgings of former years, which were deposited upon waste and marshy ground, before the present system of disposal in Loch Long was commenced. There can, I presume, be no doubt that, other circumstances being favourable, the Clyde dredgings and the sludge from the sewage would be much more usefully and sensibly disposed of by being made up into good arable land on the shores of the estuary, than by a continuance of the present system of disposal, probably followed by a similar disposal of the sludge, as recommended by Mr. Bateman.

Most of you are familiar with the Clyde Estuary, and a glance at the accompanying map will bring to your recollection that between Bowling and Dumbarton, on both sides of the river, there

**ON IN THE CLYDE ESTUARY.**  
**FREW'S PAPER.**



*NOTE - The proposed reclamation areas  
are shaded thus //*

cale



Macdonald & Co



are stretches of comparatively useless and muddy land situated upon a level about midway between high and low water. Other stretches of land of the same description extend along the fore-shore as far almost as Port-Glasgow on the south side, and from Dumbarton down to Ardmore on the north side. The cartoon map which is now before you exhibits, in a general way, the extent of these foreshores and the particular portions thereof which it is proposed to reclaim. The lands proposed to be reclaimed are shaded on the map, and extend to about 1,500 acres in all.

On the north side, between Bowling and Dumbarton, there are 250 acres; between Dumbarton and Cardross, 400 acres; and between Cardross and Ardmore, 180 acres; while on the south side, between points opposite to Bowling and Dumbarton, there are 360 acres; and still further west, in front of Langbank, there are 320 acres. Assuming that these waste lands are to be embanked to a level of six feet above high water, there is space for a total deposit of upwards of 29 millions of cubic yards of material.

On referring to a history of the River Clyde, prepared by Mr. Deas, the Engineer of the Clyde Navigation, and read before the Institution of Civil Engineers in London, in the year 1873, I find it there stated, that during the twenty-eight years between 1844 and 1872, the total material dredged from the bed of the river was 14,609,454 cubic yards, which is equal to an average yearly output of 522,000 cubic yards.

In order to arrive at an approximate estimate of the quantity of sludge which would arise from the precipitation of the Glasgow sewage, I have based my calculations upon the output of that material from the sewage works of Leeds, Bradford, Birmingham, and Leicester, and find that in Glasgow, taking the population at 700,000, the yearly output of sludge would probably amount to 60,000 cubic yards. Taking the dredgings and the sludge together, we have thus an estimated available annual quantity of between five and six hundred thousand cubic yards of material suitable in every respect for being used in the reclamation of the waste lands in the Clyde Estuary, but which is at present entirely lost through being deposited in Loch Long. The areas of the proposed reclamation are capable of containing the combined dredgings and sludge for a period of at least fifty years, and at the end of that period, if not sooner, our successors may probably discover some other and better method of disposing of these materials.

It is not necessary for the purposes of this paper to describe in detail the precise nature of the works which will be required for the precipitation of the sewage, neither is it necessary to consider, in the meantime, the engineering details relating to the position and levels of the main outfall sewer; but it may be stated that there are no exceptional difficulties in the way as regards the transmission of the sewage to the proposed precipitation works after-mentioned.

Generally speaking, the system of precipitation which most commends itself to me is that practised at Bradford. In this case there are a number of square settling tanks, about five feet deep, so arranged that the sewage can be turned into each tank in succession, or into any particular tank which may be desired. Before reaching the tanks, the sewage receives an admixture of pulverised lime, the process of mixing which with the sewage I need not detain you by describing at present. After a particular tank has been filled with sewage containing the precipitant, it is allowed to remain at rest for about one hour, during which time the sludge has been precipitated to the bottom of the tank.

The liquid, which is practically clear water, is then drawn off from the surface by means of a flexible syphon pipe provided with a float, which always keeps the mouth of the pipe near the surface of the water; afterwards the liquid passes first down, and then up, through two filter beds of coke, when the effluent which flows into the river is as clear and sparkling as champagne. The sludge escapes by a valve in the bottom of the tank, and is led into large reservoirs on a lower level, from which it is pumped into a series of large tanks where it is allowed to settle, after which it is removed, and allowed to accumulate in large heaps or mounds near the works.

In the case of works similar to those just described being applied to Glasgow, the process of disposing of the sludge might be very much simplified. At Bradford the object is to send out the sludge in a comparatively dry state, so that it will occupy as little space as possible, and because storage room is valuable; but in the case of Glasgow, where we propose to combine sewage disposal with land reclamation, the circumstances are not quite the same.

One of the points raised by Mr. Bateman is of such vital importance to any scheme of the kind which we are considering, that it cannot be passed over without remark—namely, will the

effluent from the precipitation works retain for a sufficient length of time, or until absorbed in the water of the Firth of Clyde, the unobjectionable condition in which it would flow from the precipitation tanks? This is a question which can only be answered by a skilful chemist, and as it has been the subject of recent correspondence in the newspapers by persons who are not chemists, and who are not therefore qualified to pronounce any reliable opinion upon it, I cannot do better than quote the opinion of so eminent an authority as the late Dr. William Wallace.

In his reports to the Corporation of Glasgow, Dr. Wallace wrote as follows:—

“A quantity of sewage taken from the Portland Street sewer was operated upon by lime in the proportion of one ton to the million gallons, as at Bradford and Birmingham, and also by sulphate of alumina and lime, as adopted at Coventry. The effluent, rendered clear in both cases by filtration through pounded coke, was mixed with eight times its bulk of clean Clyde water, that being the calculated proportion of the sewage of Glasgow to the ordinary flow of the River Clyde; and the samples were kept both in closed and open vessels for six weeks. They were examined weekly during this period, and at no time had either of them the least trace of offensive odour, while they remained perfectly clear and transparent. The quantity of ammonia was then carefully estimated, and it was found that nearly the whole of it had disappeared, while nitrates were present in considerable quantity.

“The oxygen dissolved in the Clyde water undoubtedly played an important part in the oxidation of the ammonia, and the results show that even without contact with the air, the admixture of eight times its bulk of Clyde water is sufficient to effectually oxidise, and so render innocuous, the organic matter in purified Glasgow sewage. It need scarcely be added that the crude sewage mixed with Clyde water is not oxidised in the same way.” And then he adds, “I am of opinion that the effluent may be run freely into the river at all states of the tide. I do not even consider it absolutely necessary that the works be situated so far down the Clyde as has been proposed.”

As the late Dr. Wallace was a man of great repute in his profession, his opinion upon a matter of this sort comes home to us with great weight. I had occasion to be associated with Dr. Wallace in one or two cases where his experience and advice

as a chemist were of the utmost importance, and from personal knowledge, I am therefore disposed to place great reliance upon anything he has said relating to this question.

The quotation which I have just made from Dr. Wallace's reports should be sufficient to dispel any doubt which some of us may have entertained as to the absolute safety of discharging the clarified effluent into the river. Dr. Wallace has said that it is not absolutely necessary for the sewage works to be situated so far down the river as Dalmuir, because the effluent may with safety be discharged further up the river; but it should not be forgotten that the point at which the effluent may be safely discharged is not the only thing to be considered in selecting the site of the proposed sewage works.

The land upon the river banks between Glasgow and Dalmuir is not all of the same value. It can be purchased at Dalmuir at so many pounds per acre, while in Glasgow a proprietor would never think of selling his ground at so much per acre, but before disposing of it he would carefully consider its value by the square yard. Generally speaking, the ground required for the three or four sewage works in Glasgow, as proposed by Mr. Muir, would cost about twenty times as much as the same area of land at Dalmuir, or any other equally suitable place as far down the river. For that reason, as well as for the others stated in an earlier part of this paper, the most judicious and economical site for the proposed precipitation works is in the neighbourhood of Dalmuir.

As regards the means to be employed for the transport and deposit of the dredgings and sludge to, and upon, the reclaimable areas, I propose to revert to a system somewhat similar to that formerly adopted by the Clyde Trustees for the transport and deposit of the dredgings, but having certain mechanical and other improvements introduced in order to dispense with manual labour as far as possible. The dredgings and sludge I propose to be taken to a landing stage at each of the reclaimable areas, by means of light iron punts, so constructed that they may be lifted bodily out of the water by a powerful crane, and brought to rest at the top of an inclined shoot. The material will then be discharged through a trap, opening downwards in the bottom of the punts, whence it will slide down the inclined shoot into waggons waiting for the purpose of removing it to the place of deposit. It is proposed to run the waggons along a light temporary line of railway from the landing stages to the place of deposit, as this

method would, in view of the large quantity of material to be dealt with, be more expeditious and less costly than horse haulage.

On referring to the map you will see that the proposed reclamation areas are of very considerable length in proportion to their breadth, and at first sight it may occur to you that there would be great difficulty in obtaining a firm enough bed upon which to lay down the temporary line of railway which would be moved about to suit the progress of the deposit. I propose to overcome this apparent difficulty by laying down the railway, in the first place, along the margin of the firm ground on the shoreward side of each area, and along the whole length of the particular area being operated upon. The deposit would be made from the waggons sideways, and would extend along the whole length of the area before returning again to deposit at the point of commencement. After as much material has been deposited as would be required to form a reasonable breadth from the first line of temporary railway, it will have had plenty of time to settle down into a comparatively firm state, when the railway will be shifted outwards; and another stretch of the deposit can then be proceeded with as before, and so on, until the outer margin is reached.

Before commencing the reclamation of one or other of the areas, it will be necessary to form a rough embankment, or breakwater, of rubble stones along the outer margin, something similar to the "long dyke" at present to be seen on the south side of the channel, between Bowling and Dumbarton. As the depth of water at the outer margins of the areas is not sufficient at all states of the tide to admit of the punts being towed to the proposed landing stages, it will be necessary to form a short canal or basin from the navigable channel of the river shorewards to each area, with the exception of the area between Bowling and Dumbarton, where deep water approaches quite close to the land proposed to be reclaimed.

There is still another important question relating to this scheme which demands our consideration, namely:—What effect will the proposed land reclamation, when completed, have upon the flow of water in the upper part of the river, between Glasgow and Bowling? I think I am able to say that the effect will be beneficial. It may be taken as an axiom in engineering that the gradual contraction of the cross sectional area in an estuary is the best form to produce the greatest possible range of tide and the greatest velocity in the river above the estuary.

So long ago as the year 1806, Thomas Telford reported upon the Clyde as follows—and for this report I am again indebted to Mr. Deas' admirable paper on the Clyde; Mr. Telford said:—“That in order to obtain a greater quantity of tide water in the upper part of the river, the general principle is to reduce the bed of the river to that form which shall afford the most direct course, oppose the fewest obstacles, and render the friction the least possible in regard to the section of the flowing water.” An examination of the map now before you will probably satisfy you that the improved estuary lines there laid down will have the effect of operating in the direction desired by Mr. Telford. Throughout the whole course of the estuary from Ardmore up to Bowling these lines present a gradually decreasing cross section in the flow of the tidal waters, and could not therefore fail to exercise a beneficial effect on the upper part of the river. The water, which at present becomes spread out at every tide over the areas proposed to be reclaimed, would be confined and forced up the river, thereby increasing the range of tide, and consequently increasing the present low velocity of the river. An increase in the range of the tide would mean greater depth of water, without any extra dredging, and an increased velocity would tend to scour the channel, and thereby lessen the amount of dredging at present required.

Taken by itself, as a land reclamation scheme, promoted by a private company, and supposing the company to get delivery of the depositing material alongside the reclamation areas free of charge, I admit frankly, and at once, that this scheme would probably be a financial failure, because in that case the benefits to be derived from the operations of such a company would be presented to the Corporation of Glasgow, and the Clyde Trustees, and other interested authorities, at the expense of the company. Take, for instance, the increase in the range of tide, and assume, for the sake of illustration, that it would be three inches. This would produce an additional depth of water between Glasgow and Bowling which would cost the Clyde Trustees half of the cost of a whole year's dredging to obtain.

Look also at the subject from another side. The Corporation must, in the event of a sewage scheme being carried out, provide for the disposal of about 60,000 cubic yards of sludge per annum, and how could this material be put to a better use than in making up these waste lands, where there would at least be some return

for the outlay? The revenue from the reclaimed lands would be close upon £4,000 per annum for agricultural purposes only, not to speak of the probability of some parts of the lands being required for purposes which would bring a much larger revenue, as has already been the case with some of the formerly reclaimed lands further up the river.

In the event of the Corporation attempting to deposit the sewage sludge in Loch Long the residents there would probably be successful in opposing that course, and the only other course open to the Corporation would be to transport the sludge out to sea, perhaps as far as Ailsa Craig, at a cost of something like £8,000 to £10,000 per annum, or alternatively to manufacture it into artificial manure by mixing with other substances, also at a heavy loss per annum. It is also within the bounds of probability that the Clyde Trustees may require to cease depositing the dredgings in Loch Long, and in that event they also would be obliged to transport their material out to sea at great cost, involving new steam barges with greater sea-going qualities than those at present in use.

No doubt the present system of deposit by the Clyde Trustees does not cost quite so much as the former system of deposit on waste land, but if the Trustees had become vested in the waste lands at their value before they were reclaimed, instead of handing over those lands in an improved state to the riparian proprietors, they would now have been possessed of hundreds of acres of river frontage lands, the revenue from which would have gone a long way in dissipating the difference in cost of the two methods of disposal, if not in wiping out the difference entirely. In connection with this it ought to be observed that the dredgings formerly deposited on land were deposited on patches here and there, and not, generally speaking, upon any very large area at one place, and this would, of necessity, make the cost higher than it otherwise might have been.

A large proportion of the former deposits were made by wheeling in barrows from the punts moored at the bank of the river, and also by horse-waggoning, and it should be quite possible, with the improved machinery and mechanical appliances of the present time, to dispense with the greater part of the manual labour involved in this custom of thirty or forty years ago, and thus still further reduce the difference in cost between the two methods of disposal.

My suggestion, then, is (1) that the Corporation of Glasgow (and by that I mean Greater Glasgow), as well as all the Local Authorities in the valley of the River Cart and upon both banks of the Clyde from Glasgow down to Bowling, jointly with the Clyde Trustees, should, for the purification of the river, for the disposal of the sludge from the sewage, and for the useful disposal of the Clyde dredgings, take Parliamentary powers to acquire the waste lands in the Clyde Estuary at their present value; (2) that in order to preserve the access which riparian proprietors at present have or formerly had to the river, canals should be formed, or roadways, if preferable, across the reclaimed lands to the navigable channel of the river; (3) that the reclaimed lands should be subject to re-purchase by the proprietors of the adjacent lands at their improved valuation, to be determined by arbitration, failing agreement; and (4) that the cost of reclamation, as well as the revenue to be derived from the reclaimed lands, should pertain to the Corporation of Glasgow, the Clyde Trustees, and all the Local Authorities concerned in the scheme, in proportion to their respective interests, as these may be ascertained or determined by Parliament.

I have thus endeavoured to sketch out, possibly in a rough and crude manner, the outline of a scheme which, after more mature consideration, would probably tend towards the solution of the sewage disposal and river purification problems in Glasgow and its neighbourhood.

These waste and weird marshes in the estuary of the Clyde, doubtless, in some aspects, present to the eye and mind of the painter subjects which he delights to picture on his canvas, forming, as they do, a pleasing foreground in the quiet beauty of that part of our river scenery; but, beautiful as they are under certain conditions of light and atmosphere, they may yet display a more substantial and enduring charm, when crowned with a splendid harvest of golden grain, and when our meanwhile black, turbid, and offensive river, restored nearly to its pristine purity, has again become the favourite resort of the silvery-scaled monarch of our Scottish streams.

XVII. — *Glimpses into Teutonic Antiquity*. By Prof. GEORG FIEDLER, PH.D., late Lecturer in Queen Margaret College and the University, Glasgow.

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[A Communication from the Philological Section, and read before the Society, 8th January, 1890.]

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OUR ancestors—I may say *ours*, for the ancestors of the English and the Germans are the same—our ancestors make their appearance in *history* in the accounts of Greek and Roman writers, but although for us the first mention of these barbaric tribes in a Greek or Roman author is the *beginning* of their history, for *them* it was the end of an epoch far longer and perhaps more eventful than that which has since passed. They make their appearance in history as a nation with a language distinct from all others, with customs of their own, and a civilisation of their own.

Now, is it not possible for us to get a glimpse into the dark age lying beyond this date? Is it not possible for us to trace them further back, to answer the questions: How was this nationality formed? From whence did they come? What was their prehistoric civilisation?

There are several sciences which may help us to answer these questions: Prehistoric Archæology, Anthropology, Ethnology, but I venture to think that the largest mass of material has been collected, and the greatest results have been attained, by the

SCIENCE OF LANGUAGE.

Language is the depository of every experience through which a people has passed, and not only every important event that convulsed the whole nation, but often also insignificant trifles have left their mark on the language. Language is, indeed,—as Emerson calls it—fossil history; and Coleridge is right when he says that there are cases in which more knowledge of more value may be conveyed by the history of a word than by the history of a

campaign. The vocabulary of a language contains every notion and conception that a people possesses. By a glance over the dictionary we obtain a picture of the state of culture of the people. If a language has a word for a thing, that thing cannot be quite unknown to the people who speak the language. We should look in vain in the Latin dictionary for words such as "railway" or "electrocution," and the Esquimaux have certainly no name for "symphony," nor the New Zealanders for "kid glove," "æsthetics," or "the philosophy of pure reason."

If we knew nothing of the civilisation of the Greeks we should be able to gather from their language that art and philosophy flourished amongst them. In the same way the Latin language would reveal to us the nation who spoke it as masters of the arts of agriculture, of war, and law-making. And if Great Britain should ever pass away, and all the records of her glorious history be lost, if only a little dictionary of the English language were preserved, the mere fact that it contains more nautical expressions than any other language in the world would tell posterity that Britannia ruled the waves.

From this it is evident that if we only possessed the vocabulary of the language spoken by our ancestors in that remote period, we should be able to know something about their civilisation.

Now, the science of language has actually succeeded in reconstructing that vocabulary to a certain extent. And how? The geologist arrives at a reconstruction of a fauna and flora which existed thousands of years ago by the study of fossils, and by the comparison of them not only with each other, but also with the fauna and flora of the present day. In a similar way the philologist, by the study of the oldest attainable forms of speech (fossils of words, as it were), and by the comparison of them with each other, and with the language of to-day, arrives at a partial reconstruction of the language spoken by our Teutonic ancestors thousands of years ago (the *Urgermanische*).

The vocabulary is not complete, but pages of it are; they lie open before us; and what do we read there?

First of all, we are struck by the relationship which these words bear to words of the same meaning in other languages, the Greek, Latin, Celtic, Slavonic, Lithuanian, and also the Persian, Armenian, and Indian languages.

For instance, from English *mother*; Dutch *møder*; Danish *moder*; German *mutter*; Anglo-Saxon *môdor*; Old Saxon

môdar; Old Norse môdhir; Old German muotar, we arrive at a Teutonic (Urgermanisch) môdar, which must strike everybody as being very like—

Sanskrit,	-	mâtár.	Lithuanian,	- .	moté.
Zend,	-	mâtar.	Greek,	-	μήτηρ.
Armenian,	-	mair.	Old Irish,	-	máthir.
Old Slavonic,	-	mati.	Latin,	-	mater.

And as this is only one out of hundreds of cases, we come to the conclusion that all these languages must have come from one common source, that they are only the offspring, and so many different forms, of one primitive language.

This fact once fairly established we may go a step farther and attempt the reconstruction of the vocabulary of even that primitive language.

The words which in all the above-mentioned (Aryan) languages agree in form and meaning we claim as an ancient common inheritance. They must have existed before the separation took place; and, if carefully interpreted, these words will tell us something about the civilisation of the people who spoke that primitive language.

For instance, if we should find that the names of agricultural implements and of all words referring to agriculture are the same in all these languages, we should have every right to say that agriculture must have been known before the separation took place. If, however, we should find that the words referring to agriculture, though agreeing in all the languages belonging to the European branch, were quite different from those in the Asiatic, we should infer that the art of tilling the soil was developed separately among the European and Asiatic Aryans respectively, in a period subsequent to their separation.

#### THE ORIGINAL HOME OF THE ARYANS.

But, perhaps, the question which interests us most is: Where did the people who spoke that primitive language live? where stood the cradle of our race? The question was asked as soon as the close relationship between the Aryan languages had been recognised at the beginning of this century, and the answer was given without much hesitation. Paradise had always been looked for in Asia. Sanscrit, the most primitive of all the Aryan languages, had been spoken in Asia. History and traditions

pointed to Asia as to the home of civilised life and culture—  
*"ex oriente lux,"* and it was, therefore, only natural that the common home of our race should have been looked for in Asia. The opinion of the Asiatic origin of our race was generally accepted, and has been held for half a century without finding contradiction from any side, although everybody was aware that the answer given was only a speculative one, a mere hypothesis.

The first person who expressed a doubt in the prevalent theory was Latham in his edition of Tacitus' *Germania*, lxvii., 1851. But the credit of having been the first to give scientific reasons for such a doubt belongs to Th. Benfey. In his preface to "*Fick's Wörterbuch der indogermanischen Grundsprache*," 1868, he attempted to reconstruct the vocabulary of the primitive Aryan language, and he suggested that, by a careful investigation and interpretation of this vocabulary, it would be possible to construct a kind of mosaic picture of the fauna and flora of the original home of the Aryans, to make out what metals and what minerals had been found there, and what the climate had been like. All that one had to do afterwards was to ascertain which country by its actual condition fitted in best with that picture. That country must have been the home of our race.

He pointed out that the Asiatic and European branches of the Aryan languages have names in common for winter—

Sanskrit,	-	hímâ,		Greek,	-	χειμών,
Zend,	-	hima,		Lat.,	-	hiems,

also for snow and ice, and he concluded that the Aryans did not come from a very southern climate (at all events, not from India). Further, we find a common name for the birch tree, which is also indigenous to the temperate zone. So far all was well, and all scholars agreed to shift the original home of the Aryans from India farther north to the sources of the Oxus and Jaxartes. But when Benfey showed that the bear, the cow, goat, sheep, dog, and horse had common names in all the Aryan languages, whereas for lion, elephant, ape, tiger, and camel no common names existed, the confidence in the old theory was shaken, and a controversy began. Benfey himself fixed the place, where the cradle of our race stood, "north of the Black Sea from the mouth of the Danube to the Caspian Sea."\*

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\* *Allgemeine Zeitung*, 1875, p. 3270.

L. Geiger,\* following in his steps, went a step farther by proclaiming Germany as the home of the Aryan race; Penkat gave his opinion for Scandinavia; and after the labours of Fr. Spiegel, Th. Pöschke, and especially after the publication of Dr. Schrader's book, "*Sprachvergleichung und Urgeschichte*,"† the majority of scholars accepted the new theory, Professor Sayce of Oxford being one of the first in this country to confess his conversion. § Of other English scholars who advocated the new view in their writings, I may mention Isaac Taylor|| and G. Rendall, Principal of University College, Liverpool, who, in 1889, read a paper before the Philosophical Society of Liverpool, on "The Cradle of the Aryans." But it was certainly going too far to say that the new doctrine was an established truth, or even better proved than the old one. It should never have been forgotten that scholars of the highest standing, such as Professor Max Müller, were not convinced by the arguments brought forward by the new school.

In an article printed in *Good Words*, 1888, and in his "Biographies of Words, 1889," Professor Max Müller, ¶ who, indeed, once felt inclined to follow Benfey, while admitting that the old theory had never been proved, points out that none of the arguments in favour of the European origin of the Aryans is of sufficient weight. He concludes with the following words:—

"I cannot bring myself to say more than *non liquet*. But if an answer must be given as to the place where our Aryan ancestors dwelt before their separation . . . I should still say, as I said forty years ago, 'Some where in Asia,' and no more."

Prof. Schrader, in the second edition of his work, speaks with far more caution on the subject than in the first; and in a paper read before the Royal Academy of Berlin, on March 20th, 1890,\*\* Professor Joh. Schmidt militates again very strongly in favour of Asia. It is very likely that his arguments will bring back a great

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\* L. G. "Ueber die Ursitze der Indogermanen," in "*Entwicklungsgeschichte d. Menschheit*," 1871.

† "*Origines Aricæ*," 1883; "*Herkunft der Arier*," 1886.

‡ An English translation of this book by Mr. F. B. Jevons has just been published under the title: "*Prehistoric Antiquities of the Aryan Peoples*."

§ In *The Academy*, Dec. 8th, 1883.—See also *Academy*, Aug. 30, 1890.

|| "*The Origin and Primitive Seat of the Aryans*" (*Journal of the Anthropological Institute*, 1888); and "*The Origin of the Aryans*," 1890.

¶ See his *Selected Essays*, i., 187.

\*\* "*Die Urheimat der Indogermanen u. das europäische Zahlssystem*."

many, if not all, to the old theory.\* More sanguine than Max Müller, he is convinced that science still may and will succeed in fixing the home of our race.

#### PRIMITIVE ARYAN CIVILISATION.

Wherever the Aryans may have lived together, they had even then advanced beyond the earliest stages of culture; they were no longer mere hunters and fishermen, but, to say the least, a half nomadic people. They were in the possession of herds and flocks, on the produce of which they lived, and had domesticated the horse, ox, swine, and dog. Very soon—probably after the European Aryans branched off from the Asiatic, and certainly before they divided into the different European nations—they made some acquaintance with the art of agriculture, as is chronicled by language.

If we look into the dictionaries of the early European languages for the word “to plough” we find—

Greek, - *aroun*. | Latin, - *arare*. | Teutonic, - *arjan*—  
all derived from the same root *ar* = to stir.

In English we had these verbs in the form “to ear” up to the time of Shakespeare, who writes—“Let them go to ear the land;” and in the Bible we read, “He will set them to ear his ground, and to reap his harvest.”—1 Sam. viii. 12.

Now, this root, common to all European Aryans, is not to be found in the Persian or Indian languages. Nor is this all! All the European Aryans, not the Asiatic, call the ground simply “ploughed land,” for the English word earth, German *Erde*, Greek *ἔρα*, are all derived from the very same root *ar*.

The English *acre*, the German *Acker*, Latin *ager*, Greek *ἀγρός* are also a common inheritance, and teach the same lesson. They are all derived from the root *ag*, the original meaning of which was “to put into motion,” as preserved in Latin *agere*, “to drive,” “to tend a flock.” Thus *acre* must have originally meant “pasture land,” just as German *Trift*, from *treiben*; but in all the European languages the word signifies “cultivated or ploughed land.” How can we account for that? There is only one way.

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\* Prof. Schmidt read his paper also at the Oriental Congress at Stockholm. When he had finished, the President, Prof. Max Müller, asked whether anybody present had something to say against the arguments brought forward by Prof. Schmidt, or in favour of the European origin of the Aryans. But no one rose; not a single dissentient voice was heard.

A change in civilisation must have taken place. What used to be pasture land, must have become ploughed land ;—the thing was changed, the name remained ; in the same way as we still speak of clerks, although now-a-days they have very little to do with the clergy ; or of sealing-wax, though the substance we seal with now-a-days is not wax ; and we use the word umbrella, which, as derived from umbra, means “a sunshade” for an instrument for keeping off, not the sun, but the rain. The doctor asks for his “fee,” but he would greatly object if you sent him what the word really means—cattle, for it is nothing but the German word Vieh, Anglo-Saxon feoh. And we still speak of “signing a letter,” although in this advanced age we write our name and no longer put our sign or cross.

Now, however far we go back in the history of the European languages, we find the words ager, &c., to mean “ploughed land,” whereas in the Asiatic languages the root *ag* has never changed its original meaning, ajra in Sanskrit always meaning Trift, “pasture land.” Thus we are driven to the foregoing conclusion, that the Aryans, while living together, were a nomadic people, but that the European Aryans got acquainted with agriculture before they divided into different nations.

By the same method we learn that the Aryans, even before their separation into the European and Asiatic stocks, became acquainted with the arts of building and navigating ; that they dressed not only in skins, but also in garments spun, woven, and sewed by their women ; and that they used arrow and bow, the spear, axe, and a short knife, as weapons, but that the shield and all defensive armour were unknown to them. They were acquainted with the decimal system of numeration, as far as 999, for the names of numbers up to this point have a common origin in all the Aryan languages, but there is no common Indo-European word to express thousand :—Greek χίλιοι ; Lat. mille. This is something of what the Science of Language has to tell us.\*

History up to this time knows nothing of the Germans. Germany was not yet discovered ; no knowledge of its existence had penetrated to the cultivated nations of Greece and Rome, and the mists that lay over the Teutonic north only cleared away very gradually.

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\* For further information on this subject, I may refer to Max Müller's “Biographies of Words,” and Dr. James Colville's paper on “Primitive Aryan Civilisation” read before the Philosophical Society of Glasgow, 1888.

## PHœNICIAN ACCOUNTS OF THE STATE OF NORTHERN EUROPE.

The first tidings about the North of Europe were brought to the Greeks by the Britons of the ancient world—the seafaring Phœnicians. Their accounts were probably overdrawn, as “travelers’ tales” are at all times apt to be. Partly, perhaps, in order to keep unwelcome competition off they may have related marvelous stories of cannibals and sea serpents to their credulous countrymen, for the idea that the north and west of Europe were inhabited by giants, cannibals, and all sorts of monsters is clearly traceable in the *Odyssey*. But the *Odyssey* also proves that the Phœnicians were not all braggarts, but that some of their tales were true. Müllenhoff has pointed out a passage in the *Odyssey* in which the long days and the midnight sun of the northern latitudes are plainly alluded to.\* We find the passage in the 10th Book, verses 81-86. It runs as follows:—

“For six days we sailed both night and day, but on the seventh we came to the lofty city of Lamos. There a man who does not sleep would be able to earn double pay, for the ways of night and day are near, and almost join.”

## ANCIENT MAPS OF EUROPE.

The inheritance of the Phœnicians was entered upon by the Greek colonies of Asia Minor, particularly by Miletus. Trade flourished here anew, and with trade the knowledge of geography extended. In Miletus the first attempt was made to draw a representation of the earth. (We leave aside the attempts made in Egypt about one thousand years before that; they had been forgotten, and the Greeks were obliged to start anew.) Anaximander of Miletus, the pupil of the philosopher Thales, living in the sixth century B.C., is reported to have been the first to sketch a map of the world. This map was afterwards much improved by the great traveller Hecataeus of Miletus, who also added a written explanation to it—the first known description of the earth.

The story told by Herodotus is well-known—that Aristagoras, tyrant of Miletus, brought a representation of the world, engraved on a brazen tablet, with him to Sparta, to King Kleomenes, in order to induce the latter to declare war against Persia. This tablet was most likely nothing else than the map of the world made by Hecataeus. Judging by the fragments of the geographical work of Hecataeus which have been preserved to us, and from the account given by Herodotus, the map must have looked something

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\* *Deutsche Altertumskunde*, vol. i., page 5.

like this :—The earth is represented as a circular disc, surrounded by the ocean. Delphi, the seat of the sacred oracle, occupies the centre, as the most important point—the umbilic of the earth. Northern Europe, most probably, looked on that map very much like the centre of Africa on the maps of the last century—a mere blank, marked as unexplored, unknown land—*terra incognita*. The inhabitants of it went by the general name of “Scythians.”

GREAT BRITAIN AND GERMANY DISCOVERED BY PYTHEAS  
OF MARSEILLES.

It was not till the end of the fourth century B.C. that a Columbus, a Livingstone, arose for our fatherland in the person of Pytheas of Marseilles. Pytheas stood in the front rank among contemporary astronomers and geographers, and bent all his energies to the discovery of the North Pole. In or about the year 325 he passed through the Straits of Gibraltar and sailed northwards on the first “North Polar Expedition” known in the history of the world. The north pole was not found by him; but, just as Columbus, when sailing for India, discovered America, the expedition of Pytheas, although failing in its original purpose, led to the discovery of Great Britain and Germany. This happened at about the same time that Alexander the Great was descending the Indus to explore the East, Persia, and India; so that this age in enterprise and success in exploration and discovery is only inferior to the age of a Columbus and a Vasco de Gama.

Pytheas put down the results of his voyage in a document entitled “Across the Ocean,” which, unfortunately, has only been preserved to us in extracts to be found in the works of other writers (Eratosthenes, Strabo, and Plinius). He sailed along the coast of Spain and France, and from Brittany he crossed over to England, or “Albion,” as he calls it. He gives a somewhat full account of this country and its inhabitants, but as the latter were at that time Celts, it would be foreign to my subject to enter into details. It may, however, be of interest to hear this much :—He found the country cold, damp, and foggy; the people lived principally in wretched huts made of wood and straw, and were governed by kings and warlike chiefs. They were acquainted with agriculture, cultivated grain, especially barley, from which they made beer.

He sailed up the west coast of England and Scotland, and seems to have found much difficulty in navigating the deeply indented

coast of the latter. He reached the Orkneys and Shetlands about the time of the summer solstice, and saw "the nights without darkness" of which Homer had sung, the natives showing him on the horizon the place where, as they naïvely expressed it, the sun goes to rest.

Pytheas now turned to come back. He descended the east coast of Scotland and England as far as Kent, from whence he crossed to the Continent, and from about Dunkirk or Ostend he sailed eastward. How far he got we do not exactly know, but he passed by the mouths of the Scheldt, the Maas, and the Rhine. As he only spoke Greek he had taken a Celtic interpreter with him, but even he now failed; the Celtic language was no longer understood; they were on German soil. He heard this new people called "Teutons," which was in all probability simply a corruption of the German word *thiuda*, that is to say, *people*; the same word from which later on the name for our language and nationality was derived. For *deutsch* is in its older form *thiudisc*, which means belonging to the people—"popular." Our language was called so in the middle ages, in contradistinction to the Latin language used by the clergy. The German word *deuten* is derived from the very same root, and means "to interpret something"—"to make something intelligible to the uneducated, the laic;" "*deutsche sprache*" and "*deutliche sprache*" are therefore almost synonymous, however strange it may seem to some of you—both meaning a language intelligible to the great mass of the people.

Pytheas made only a very short stay in Germany, as the impossibility of finding anybody who could act as an interpreter between him and the Teutons made further progress impossible, and so he returned.

#### FIRST CONTACT BETWEEN GERMANS AND ROMANS.

Another 200 years were to pass away before the Romans and the Germans first came into contact with each other, and this first meeting was as enemies. The Teutons, whom Pytheas had found on the shores of the North Sea, had (probably on account of terrible floods) left their homes, and, with wife and child and all their movable possessions migrated to the south, where they were joined by the Cimbri. Teutons and Cimbri then crossed the Danube and the Alps, and threatened the fertile fields of Italy with invasion. Here we have the beginning of the conflicts between the Germanic and Roman world, which have gone on ever since, and do not seem to be yet at an end.

They were beaten back in the famous battles of Aquæ Sextiæ and Vercelli; but Rome had trembled, and the "*terror Cimbri-cus*" became a proverbial expression just as once "*Hannibal ante portas*" had been.

The effeminate Romans looked with astonishment and admiration on the powerful forms of the Germanic prisoners, who were led in triumphal procession through the streets of Rome; on their fair locks and bright blue eyes; on the stately women, who were only little inferior in size and strength to the men; and on the children with the old man's hair, as the amazed Italians called the flaxen-haired youths of the north. Rome foresaw from whence destruction was to come upon the empire, and looked ever afterwards with anxious eyes and awe at the thunder-clouds which lowered behind the Alps. The incursion of the Cimbri and Teutons was but the first distant lightning flash which announced the coming storm.

#### HOW CÆSAR DESCRIBED THE GERMANS.

When, in the years 58-51 B.C., Cæsar was in Gaul, he had to fight with German tribes, who crossed the Rhine and threatened the newly-conquered province; and in his *Commentaries on the Gallic War* (a sort of diary which he kept during that campaign) he gives a description of the barbaric foe. He is the first to distinguish clearly between Gauls and Germans. After giving a minute description of Gallic customs, particularly of their religious ceremonies, and of the Druids who conducted them, he proceeds—

"German customs differ much from those of the Gauls, for they neither have priests to preside over sacred matters nor do they pay great attention to sacrifice. Among the gods, those alone are respected whose existence is perceptible to them, and from whom they receive evident benefits—namely, the Sun, Vulcan, and the Moon. The others are unknown to them, even by name. Their whole life is spent in hunting and in military pursuits; from childhood up they inure themselves to toil and hardship. . . . They do not pay much attention to agriculture, and the greater part of their food consists of milk, cheese, and meat; nor has anyone a fixed portion of land or settled boundaries, but each year the magistrates apportion to the different families the piece of land which they think fit for them, and at the end of the year they are compelled to move elsewhere.

"For this practice they allege many reasons:—That they may not be tempted to exchange their warlike pursuits for those of agriculture; that the more powerful may not procure extensive estates, and drive out their weaker brethren from their possessions; that their houses may not be too

luxuriously arranged; that the lower classes may be contented with the idea that the possessions of the humblest are equal to those of the most powerful.

"In times of war, magistrates are chosen to preside over military affairs, and to have the power of life and death; in times of peace there is no common magistrate, but the chieftains of districts and cantons administer justice and decide disputes.

"They deem it an act of injustice and a great wrong to do any injury to a guest; those who come to them from any cause whatever are protected from harm and considered inviolate, and hospitality is everywhere offered to them."

In judging of Cæsar's description, we must not forget that he is writing of the enemies of Rome, and that his account is chiefly made up from what he heard from his Gallic friends. But even without considering this, I fail to find in the account any reason for ascribing to our ancestors "want of all sense of duty and propriety, and incapability of self-control," as has often been done even by eminent historians.\*

In the following years the Romans and Germans became better acquainted with each other. On the frontiers, by the Rhine and Danube, Roman discipline was often obliged to measure its strength with the heroic courage of the Germans. The impetuosity of the German attack was hard to resist, the "*furor teutonicus*," as it was called by the poet Lucanus, made even the staunch Romans tremble.

#### PEACEFUL INTERCOURSE BETWEEN ROMANS AND GERMANS.

But a more peaceful intercourse unfolded itself at the same time. The merchants of Rome sent their wares to Germany: weapons and ornaments, household goods of various kinds, wines and the fruits of the south!; and received in return the products of the north: skins, buffalo horns, and goose feathers for the cushions of the effeminate Romans. Moreover, many Germans took service in the Roman armies, and many a stalwart German youth was to be found in the bodyguard of the Emperor Augustus. Language steps in again and tells us the story of this mutual intercourse. Roman words crept into the German language, especially those most necessary for barter and traffic, for example:—

Latin: <i>monēta</i>	became	Old High Ger.:	<i>munizza</i>	—Mod. Ger.:	<i>münze</i>	(mint).
„ <i>pondo</i>	„	„	„	<i>pfunt</i>	„	„ <i>pfund</i> (pound).
„ <i>strāta</i>	„	„	„	<i>strāza</i>	„	„ <i>strasse</i> (street).
„ <i>mīlia</i>	„	„	„	<i>mīla</i>	„	„ <i>meile</i> (mile).

\* As by Wilhelm Scherer in his "*Geschichte der deutschen Literatur*," p. 1.

And as we call our colonial products by their Asiatic or American names (cocoa, tobacco, potato, &c.), so at that time Roman names along with Roman articles made their way into Germany.

The Latin *piper* became O. H. Ger. : pfeffar—Mod. Ger. : pfeffer (pepper).  
 „ *vinum* „ „ „ win „ „ wein (wine).  
 „ *persicum* „ „ „ pfersich, „ „ pfirsich (peach).  
 „ *pulvinus*, „ „ „ pfuliwi „ „ pfühl (pillow).

#### ROMAN EFFORTS TO CONQUER GERMANY FRUSTRATED.

Violent efforts were made by the Romans to incorporate the land beyond the Rhine and Danube into the empire; but in vain! Drusus did, indeed, lead his legions across the Rhine as far as the Elbe and Weser, and Roman camps, forts, and castles were erected; but a few years afterwards the German tribes made a united effort and completely annihilated the Roman army in a battle in the Teutoburg Forest, under the leadership of Arminius (9 A.D.).

We can hardly overrate the importance of this victory for the history of our race. Had Germany been defeated she would have been Romanised like France and Spain, and her language would most likely not have been very different from French or Spanish. Nay, even the language spoken in *this* country would no doubt have been very different from what it is now—for the continental tribes who settled in England about 400 years after that battle would not have brought a Teutonic speech but a Roman dialect across the sea.\*

The three campaigns of Germanicus were also fruitless; Roman military tactics were of no avail in the dense forests of Germany and the country remained free, unconquered, and—German!

#### TACITUS ON THE COUNTRY AND MANNERS OF THE GERMANS, 98 A.D.

How often at that time must Germany have been the subject of conversation in the Roman Forum and in the halls of the houses. What stories must have passed from mouth to mouth, and how eagerly must the few have been questioned who had come back from the country beyond the Alps. For, except the short account written by Cæsar, there existed at that time no book about the

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\* I still strongly believe that the English *are* the descendants of Low German tribes (the Angles, Saxons, Jutes, and Frisians), and am not able to accept M. Du Chaillu's extraordinary theory, started in his "Viking Age," 1889, that the English are not English at all, but somebody else—Scandinavians, Vikings.

wonderful country. At last, 90 years after the defeat of Varus, in the winter of 98-99, the historian Tacitus wrote down all the information that he could collect about Germany and its inhabitants, in his celebrated work, "*De origine, situ, moribus ac populis Germanorum*" ("On the Country and Manners of the Germans"):

"The Germans," he says, "are of immense stature, with fierce blue eyes and red hair. Their possessions consist almost entirely of flocks and herds. For gold and silver they care but little; vessels of silver which have been presented to their envoys are held as cheap as if they were made of clay. Only on the frontiers they begin to value Roman money on account of its utility in intercourse with the Romans. Their dress consists chiefly of skins, which they throw carelessly round them and fasten with a clasp or thorn, leaving the rest of their persons bare. The women, however, generally wrap themselves in linen garments, which they embroider with purple.

"They are moderate in eating, and their food is of a very simple kind, consisting of wild fruit, fresh game, and curdled milk. In drinking, however, they are less moderate; to pass an entire day and night in drinking is considered no disgrace. They drink a liquor made of barley or other grain, and fermented into a certain resemblance to wine."

And the Roman historian adds: "If you indulge their love of drinking by supplying them with as much as they desire, they will be overcome by their own vices as easily as by the arms of an enemy." There is nothing new under the sun! Here is the same ruse, the same means which gave many a wild tribe into the hands of the civilised Europeans, devised by a Roman against their ancestors!

Tacitus, as Cæsar before him, is loud in his praises of German hospitality:

"To exclude any human being from their dwelling is considered impious. Every German, according to his means, welcomes his guest to a well-furnished table; when his supplies are exhausted, the host takes his guest to another house, the cordial hospitality of which they enjoy, as a matter of course, and without invitation. It is usual to give the parting guest whatever he may ask for, and a present in return is asked with as little hesitation.

"They reverence their women, and even believe that the female sex has a certain sanctity and prescience, and they do not despise their counsels or make light of their answers" ('as the Romans do,' Tacitus means to say).

"When they are going into battle their wives are close to them, they are to every man the most sacred witnesses of his bravery; they are his most generous applauders. The warrior brings his wounds to mother and wife, who shrink not from counting or even demanding them.

"Their marriage code is strict, and contrary to the general rule among barbarians, they take only one wife. The wife does not bring a dowry to

the husband (namely, 'as with us in Rome'), but the husband to the wife. Lest the woman should think herself to stand apart from aspirations after noble deeds or shut out from the glories and perils of war, she is reminded in the marriage ceremony that she is her husband's partner in toil and danger, destined to suffer and to dare with him both in peace and in war. The loss of chastity meets with no indulgence; neither beauty, youth, nor wealth will procure the culprit a husband. No one in Germany laughs at vice."

Tacitus considers it beyond a doubt that the Germans are aborigines, "for who," says he, "would care to live in Germany, with its wild country, its inclement climate, its gloomy aspect, and sullen manners, unless it were indeed his 'fatherland?'"

The same historian makes a conjecture also as to the origin and meaning of the name of that people and country.

#### GERMANY, WHY SO CALLED.

When Tacitus wrote (98 A.D.) the name had not long been in use yet in Rome. It was quite a new word, as he himself expressly says.\* We find the name first on an old Latin inscription referring to some barbarians siding with the slaves in the servile war (73-71 B.C.). The first author who uses the word is Cæsar.

Tacitus expresses the opinion that it was originally the name of a single tribe settled on the Rhine, and that from them, as living nearest to the Gauls, it was gradually extended over the whole people. There is nothing surprising in that. The French have done, and still do the same when they call the whole German nation by the name of the German tribe living next to them, the Swabians or Alemanni, *les Allemands*.

The meaning of the name was a puzzle to the ancients. They naturally enough connected it first with words of their own language, so, for instance, with the Latin word *Germanus*, from which the English *german* is derived—a word almost obsolete, except in the expression "cousin-german." Now, at first sight the connection of these two words, German and german, seems quite obvious, and one could hardly be astonished if a modern Englishman connected them; the less so as he knows that his people and the people in the fatherland are something like cousins-german. And so we cannot wonder that Plutarch and Strabo were also misled, and described the Germans as the "brethren," or at any rate, "cousins-german" of the Gauls, to whom they bore so much resemblance.

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\* *Ceterum Germaniæ vocabulum recens et nuper additum.*

The scholars of the Middle Ages displayed a marvellous ingenuity in deriving this word from all sorts of Latin words. There is, for example, the monk Jordanis, who is responsible for a great many mistakes which have crept into the historical literature of the Middle Ages. He, like all his contemporaries, believed in the story that the population of Europe, especially the Italians, Germans, and the people of this country, were the descendants of Æneas, who had fled from the ruins of destroyed Troy. He made a very ingenious conjecture. "The Germans are descendants of the Trojans; in other words, they have sprung from the *germ* or seed of the Trojans. Now what else, therefore, can their name be derived from than from the word *germ*!"

Geoffrey of Monmouth, the historian of this country, tells us that the grandson of Æneas came to England, and that from his name *Brute*—*Brutannia*, that is to say, *Britannia* received her name. He had twenty sons, all of whom, except the eldest, who became King of *Britannia*, settled in the land between the Rhine and the Elbe, and that land was then called *Germany*, because it was the land of the nineteen brothers or *germans*.

Spenser, in his "*Faëry Queen*," has taken up this wonderful wisdom. He tells the same story, and says:—

"These Germans did subdue all Germany,  
Of whom it hight." . . . .

"*Faëry Queen*," II., 10.

Isidore, Bishop of Seville, writing about the year 600, has also a shot at the etymology of this puzzling word, and a very good shot it is. He derives it from Lat. *germinare*, to *germinate*, or bring forth; "because," as the worthy bishop says, "the Germans bring forth so many children."

In the beginning of this century attempts were made to trace the name to a German root. Some writers said it was nothing else but *warmen*, "*warriors*," deriving it from Old High German *werra* = war. They accounted for the *g* instead of *w* by the fact that the Romans could never pronounce the German *w*, which at that time had the sound of the English *w*, and replaced it in all the words which they took from the German by *gu*. Thus the Old High German word *werra* became, in the mouth of a Roman, *guerra*, whence Italian *guerra*, French *la guerre*. Other scholars thought of the Old High German word *gêr* = spear, supposing that the Germans had

been called *spear-men* after the principal weapon they used in battle; others, again, derived the name from *heri* (modern German *heer*) = army; so that Germans would be *heermannen* = army men.

But none of them was right. None of these etymologies holds good when we come to examine them in the new light which has been thrown on the history of our language by Comparative Philology. The word *ger*, for example, was in that remote period *gais* as we have it in names such as *Gaiseric*, *Radagaisus*. Had the name therefore been derived from this word it would have appeared in the Roman writers as *Gaisomanni* but not *Germāni*.

The name is not Roman, but just as little is it German. Never do we find it used by our ancestors themselves; never does it appear in the relics of old German, Anglo-Saxon, or Scandinavian poetry. But what then can it be? We must take into consideration from whence the Romans got that word; they got it from the Celtic Gauls. There is the explanation! It is a Celtic name, given to the German people by their neighbours. Now the task still remains to us of deriving it from a Celtic root.

Of the many theories which have been put forward I will at once give the most likely one, which is now generally accepted. It is that of Caspar Zeuss, the founder of Celtic Philology. He derives it from the Celtic word *ger* meaning neighbour. And that is very plausible indeed, and makes everything smooth and clear. When the Romans asked the Gauls the name of the tribes beyond the Rhine, they received, in Celtic, the answer: "We call them simply our neighbours—Germans."

#### OLD GERMAN BATTLE SONGS—BARDITUS.

Then we find Tacitus speaking of battle songs, "which the Germans strike up as they are advancing to the fight, in order to raise their own courage and to intimidate the enemy; the recital of which they call 'Barditus.' They aim chiefly at a harsh note and a confused roar, putting their shields to their mouths to make it reverberate and swell into a fuller and deeper sound" (*Germania*, chap. 3). Although Tacitus speaks of battle *songs*, "*carmina*," we can hardly think that he means regular songs, they were mere battle *cries*.

In the last century, however, people believed them to have been regular poetry, connecting the word "*barditus*" with the Celtic word *bard* = a poet, and thus interpreting it as "a poet's song." It became an axiom that there had been a caste of bards among

our ancestors, as well as among the Celts, and Klopstock and his followers, fired with patriotic enthusiasm, were never weary of composing what they considered "Songs of the Bards," a bombastic sort of poetry, written in a queer, quaint language, which can hardly claim to be German, at any rate not "Deutsch" in the sense in which we have just interpreted the word.

But "barditus" has nothing whatever to do with the word bard, for the latter is Celtic. Tacitus, however, says that *they*, the Germans, call it "barditus," it must therefore be a German word. Besides, the fact had been overlooked that Tacitus says, they call the *recital* of these songs (not the songs themselves) barditus.

What, then, does the word mean? Just to show what can be done in the line of etymologies, I will give the interpretation of two eminent philologists who died only a few years ago—Müllenhoff and Scherer, both professors at Berlin University. They both interpreted the word as Bartrede = "speech in the beard." Now, at first sight, such an explanation seems simply ridiculous, but it was not a mere guess. They supported their argument by the quotation of a passage in the Norse legend of Olaf, in which the "speech in the beard" of the God of Thunder is mentioned.

The God of Thunder trembles for his throne, as King Olaf strives to introduce Christianity. In his wrath he mutters angry words in his red beard, and immediately the red forked lightning flashes out from it and strikes King Olaf.

But even taking this into account the explanation seems improbable and artificial. Barditus is certainly to be derived from the old German word bort (English board) that originally also meant "shield." Barditus therefore is "shieldsong," "bordsong," and this meaning becomes quite clear when we remember what Tacitus said—

"They chiefly aim at a harsh note and confused roar, *putting their shields to their mouths* to make it reverberate and swell into a fuller and deeper sound."

#### FIRST NOTICE ABOUT GERMAN LITERATURE.

But in another passage we really get from Tacitus the first notice about German Literature. He tells us of songs which the Germans sang in honour of the earth-born god Tuisko, which, probably, were songs in the forms of hymns on the one-armed God of Battle, Týr, A.-S. Tiw, the same whose memory still lives in the name of "Tuesday," the day sacred to the God of War, corresponding

to Mardi, Dies Martis. In his Annals the same Roman writer tells us of songs in honour of Arminius, the liberator of Germany, which, in the time of Tacitus, were still sung by the barbarians at their feasts, or when they were gathered round their watch-fires in camp, and during funeral solemnities. These songs of the gods and heroes have died away, no trace of them remains. The only literary remains that have been preserved to us out of that dim past are the beginning of a poem which probably contained a description of the world—The Wessobrunn Prayer, and two forms of Incantation.

#### THE WESSOBRUNN PRAYER.

Let us consider first the fragments of the poem. In the eighth or ninth century a monk of the monastery of Wessobrunn, in Alsace, made for himself a sort of scrap-book, in which he wrote down everything that seemed to him worth knowing—historical dates, geographical notes, the weights and measures, the elements of grammar, rhetoric, mathematics, and astronomy—in short, a forerunner of “Whitaker’s Almanac.” Then he may have heard from the mouth of an outsider a poem about the beginnings of all things which seemed to him worth recording, so he wrote it down. It begins thus:—

“This I heard as the greatest marvel among men, that there was no earth nor heaven above, the bright stars gave no light, the sun shone not, nor the moon nor the glorious sea.”

There is an old Icelandic song preserved to us in the *Völuspá* very much like this, describing the primeval chaos as follows:—

“There was neither sand nor sea nor salt wave,  
There was no earth nor heaven above,  
There was a yawning gulf and no firm land anywhere,  
Sun had no seat, moon no might, stars no stead.”

From the almost verbal agreement of these two poems, coming from countries which lie so remote from each other, we may conclude the existence of an original work of very great antiquity which served as basis to both. Both in the *Völuspá* and in our fragment we have the pagan conception of primeval chaos. The monk saw fit to add a few lines giving the Christian doctrine of the creation of the world out of nothing, taking them perhaps from a contemporary poet:—

“When waste was everywhere, there was then the only God, mild and almighty, and many good spirits with him. And the holy God——”

Here his memory or his invention fails him; he breaks off the

poem and continues with a prayer in prose, in which he beseeches the Creator of heaven and earth, the giver of all good gifts, to grant him true faith and wisdom and power to resist the devil.

#### FORMS OF INCANTATION.

We come now to the two Forms of Incantation. They were discovered in the year 1841 in a Latin codex of the tenth century, in the Cathedral Library at Merseburg.\* The first was supposed to have power to loose the chains of a prisoner :

“ Once the divine Valkyries, virgin goddesses of battle, ruled over and ordered the event of the battle. They formed themselves into three bands. The first secured the prisoners in the rear of the army, which they favoured. The second engaged the foe, and the third appeared in the rear of the enemy, where the prisoners were secured, and touching their fetters they uttered this formula of deliverance : ‘ Cast off thy fetters, escape from the foe.’ ”

The words having proved themselves on this occasion to be possessed of magic power, the same result was hoped for from their repetition under all similar circumstances.

So with the second form of incantation found at Merseburg, which was supposed to have power to cure the sprain in a horse’s leg :

“ Phol and Wodan were once riding in the forest, suddenly Balder’s horse sprained its foot. Sindegund and her sister Sunna uttered a charm over it. Volla and her sister Friya did the same, but all in vain. Then Wodan, the wonder worker, uttered his incantation; he charmed away the sprain in the bone, the blood and the joint by means of this miraculous formula :

‘ Bone to bone, blood to blood,  
Joint to joint as if they were glued.’ ”

It is remarkable that this incantation, with the names of the heathen gods, should have found its way into a Christian manuscript of the tenth century, that a monk should have chosen to record these shunned and dreaded names. It shows the power which the old superstition still held over the people, learned and unlearned alike. The old gods might be execrated as devils and demons, but still the people were willing enough to make use of the magic powers which they believed to be connected with their names.

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\* Discovered by Dr. Geo. Waitz, and first printed by Jacob Grimm in the *Transactions of the Royal Academy of Berlin*, 1842.

Charms and incantations continue in use among the people up to the present day, and although the names of the heathen gods have been replaced by those of Christian saints, yet the old form is still clearly discernible. As late as in the last century, the same incantation, of which we have been speaking, was copied down almost word for word in Denmark, from oral tradition. Only the name of Jesus had taken the place of the names of the heathen gods. And in Scotland a form of this incantation was still in use among the people fifty years ago, and may be to the present day.

#### A SCOTTISH FORM OF INCANTATION.

In Chambers' "Popular Rhymes of Scotland" (Edinburgh, 1842, page 37), we read :

"When a person has received a sprain it is customary to apply to an individual practised in casting the wresting thread. This is a thread spun from black wool, on which are cast nine knots, and which is tied round a sprained leg or arm. During the time the operator is putting the thread round the affected limb, he says, but in such a tone of voice as not to be heard by the bystanders nor even by the person operated upon :

" 'The Lord rade,  
And the foal slade ;  
He lighted,  
And he righted ;  
Set joint to joint,  
Bone to bone,  
And sinew to sinew.  
Heal in the Holy Ghost's name ! ' " \*

How exact the agreement between this version and the Old German ! Here we have an example of faithful preservation from the tenth to the nineteenth century in Germany, Scandinavia, and Scotland ! We can also trace it back into old Indian times,† so that we have here a little bit of genuine Indo-Germanic antiquity, which our forefathers must have brought with them from their original home, wherever it may have been, and which has come down to us as a monument of the past and a witness for the relationship of the Indo-Germanic races.

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\* A slightly different version of this charm is printed among some other "Orkney Charms" in *Notes and Queries*, September, 16th, 1854. See also "Charms from Devonshire" in *Notes and Queries*, April 5th, 1851; and "The darker Superstitions of Scotland," by Sir John Graham Dalyell, Glasgow, 1835, page 27.

† "Atharva veda," iv., 12. See Kuhn's "Zeitschrift," vol. xiii.

The second Merseburg Incantation is rendered particularly important by the fact, that in it are preserved a number of names of old German gods : Wodan, Phol, Baldur, Friya, &c.

#### GERMANIC MYTHOLOGY.

We know, indeed, very little about the gods of our forefathers, and the investigation of Teutonic mythology is connected with far greater difficulties than that of Greece or Rome. No monuments of plastic art come to our aid and preserve for us the mythological legends of Germany in the way that bronze and marble statues, frescoes, and the decoration of vases have preserved those of Greece and Rome. The limited use of writing rendered contemporary records impossible, and the accounts handed down to us by Roman historians are meagre and unreliable.

Jacob Grimm, however, with the painstaking industry and penetration of a great scholar, and the sympathetic insight of a genuine poet, has endeavoured to reconstruct the edifice of Teutonic mythology by the help of popular tales, legends of the saints (who very often bear some features of a heathen god), old popular games and rhymes, names of places, mountains, and rivers, traditions, superstitions, popular customs—in short, what we call folk-lore.\* It was an arduous task, for the missionaries in their pious zeal had half intentionally, half unconsciously, destroyed everything that could keep alive the memory of the old gods. But what he did not find in Germany he found in a little island in the north, in Iceland, where a more fortunate star presided over the folk-lore of our forefathers. There, in the remotest corner of the earth, it remained like the fires of Hecla, buried under the snow and ice of glaciers. Christianity did not penetrate this Ultima Thule till the tenth century, and the bleak penurious island enticed few foreign priests to its shores. The proclaimers of the Cross there were natives, who, in spite of the new faith, had kept their love for their lonely fatherland, for their old language, their old poetry, their sagas, and legends. *They* were the preservers of the old songs, and in the twelfth or thirteenth century an Iceland† collected all the legends of gods and heroes which were still to be found. This is the so-called

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\* "Teutonic Mythology," by Jacob Grimm, translated from the 4th German edition by J. H. Stallybrass. 4 vols.

† Bishop Saemund Sigfusson (1055-1132) used to be credited with this collection.

"Edda," that is to say, great-grandmother or ancestress, because this book, like an old grandmother, tells the young generation gathered round her the story of the past.

This work, which in its plan may be compared to the "Theogony" of Hesiod, contains a fully-developed system of Germanic thought and speculation on subjects human and divine. This system, of course, only applies to the north of Europe, and to a somewhat late period; we may, however, safely claim the fundamental ideas for the whole Germanic race and for an earlier period of history. Making thus a cautious use of the Edda, aided by the folk-lore of the present day, and the scanty accounts of Roman historians, we may now venture to sketch a picture of Teutonic mythology.

Our forefathers built no temples, and made no images of their gods. According to the account of Tacitus they thought it inconsistent with the majesty and dignity of the gods to confine them within the walls of a temple or to represent them in human form. Amid the wilds of nature, in the impenetrable forest, on the mountain-top, by fountain and stream, in the sacred grove beneath the shade of old trees, they offered prayer and sacrifice to their invisible gods. Oxen, rams, and especially horses were sacrificed as thank- or peace-offerings to the gods, and their skulls were hung up on the trees of the sacred grove. But there is no possibility of doubt that the altars of the old German gods, like those of ancient Greece, were also stained with human blood. \*

Enormous bonfires were lighted in honour of the gods, particularly at the time of the summer and winter solstices. The custom still survives in the St. John's fires, which, in Middle and South Germany, are still kindled on midsummer's night, and the English Yule log and the German Christmas tree also have their origin in that heathen custom.

#### THE SUPREME DEITY.

Wodan (O.H.G. Wuotan.—O.N. Odinn) was worshipped as chief among the gods. Cæsar and Tacitus no doubt mean him when they say that Mercury was honoured by the Germans as chief among the gods. Wodan must have borne much resemblance to that Roman god, for when the Roman names for the days of the week were introduced into Germany, the day which among the Romans was dedicated to Mercury came to bear the name of Wodan in Germany.

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\* Tac. Germ. 9. Deorum maxime Mercurium colunt, cui certis diebus *humanis* quoque hostiis litare fas habent.

Latin Dies Mercurii; French Mercredi; Anglo-Saxon, Wôdnes daeg (Wednesday). The German Mittwoch is of later date.

Wodan was specially worshipped as God of the Storm. When the hurricane swept at midnight over the land, our forefathers heard in it the noise of Wodan's hunting train, the neighing and snorting of steeds, the barking of hounds, cracking of whips, and the loud hurrah and holloa of the huntsmen. Following close on the heels of the wild pack, on a snow-white steed, rides Wodan, the one-eyed (for the sun is his eye); he wears a broad-brimmed hat, a long black mantle floating in the wind, and the mighty hunting spear is in his hand. A long train of gods and goddesses, wild and fantastic as a midsummer night's dream, follow him.

Well may our forefathers, when they heard the storm roaring round their lowly huts, have drawn closer together round the hearth and whispered "Wuotan jagit!"—"Wodan goes a hunting!"—as the peasants in Mecklenburg still say, when the spring storms sweep over the land. They heard him pass with awe, but not with fear; they believed that he was fighting the powers of darkness and winter, who had put the earth into chains and fetters, and banished light and warmth; they knew that at last he would succeed in subduing them, and that then Spring would come, and all good spirits, light, and warmth would return.

This belief had such a strong hold over the minds of the people that the missionaries had to give up trying to convince them that these gods did not exist at all. All that they could do was to execrate them, and to turn them into evil spirits and demons. And so they lived on. Wodan still haunts the midnight forest in the lonely valleys of the Harz Mountains as the Wild Huntsman, riding on a black, headless horse, and when a thunderstorm sweeps over the Eichelberg or the Bodethal—that is to say, Wodan's dale, the peasants still hear in the blast of the wind the holloa of the hunters and the clamour of the hounds.\*

#### THE GOD OF WAR.

Tacitus mentions Mars together with Mercury. The god he means is no doubt the O.H.G. Zio, O.N. Týr, A.-S. Tiw, the God

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\* Julius Wolff, one of Germany's best living poets, has taken the legend of the Wild Huntsman as subject for an epic tale (*Der wilde Jäger*), at the beginning of which he gives a beautiful description of Wodan's fight with Winter.

of Battle ; for Tuesday, as we have seen, corresponds to Dies Martis, Mardi.

In Gothic the name of this god would be Tius (gen. Tivis), which form shows still better that it is etymologically the same as Greek Ζεύς, gen. Διός, archaic Διφός, and Latin Jupiter, standing for Dius Pater, gen. Jovis, original *dj* being turned in Greek into ζ, in Latin into j; and they all correspond to Sanskrit *dyaus*, gen. *divas* = bright sky.\*

He was supposed to have only one arm with which he brandished his sword—the protection by a shield, often refused and despised by the Teutonic warriors themselves, being thought quite inconsistent with the dignity and courage of their warlike god. Many features of this god appear again in the Christian hero, St. Michael.

#### THE GOD OF THUNDER.

Thôrr (O.N.), Donar (O.H.G.), Thuner (Anglo-Sax.), was the God of Thunder ; from his red beard flashes forth the lightning, and the stroke of his mighty hammer makes the thunder roll. In later times he was connected with the Roman God of Thunder, Jupiter, and Dies Jovis (jeudi) became Thursday (Donnerstag).

#### GODDESSES.

Among the goddesses were pre-eminent Frigg, the spouse of Wodan, and Friya, a bright young goddess, the German Venus, sometimes known as Berhta—Bertha, that is to say, “the bright one.” She is the leader of the Valkyries. It is told that her husband (Odhr) left her, and that she wandered over the world to seek him, shedding golden tears.

On account of the similarity of name, these two goddesses are often mistaken for each other; characteristics which originally belonged to the one are ascribed to the other, and we are not sure which of the two has come down to us in the name of Friday = Dies Veneris, Vendredi.

#### DEMIGODS.

Lower in rank than these come a whole crowd of demigods, wights and elves, giants and dwarfs, nixies and water-spirits, kobolds and goblins. For Nature to the German, as to the Greek,

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\* See Max Müller's Lectures on the “Science of Language,” new edition, ol. ii., p. 468.

was instinct with life. What Schiller says of the Gods of Greece applies equally to those of old Germany :—

“ Man gifted Nature with Divinity,  
To lift and link her to the breast of Love.  
All things betrayed to the initiate eye  
The track of Gods above.

“ On yonder hill the Oread was adored,  
In yonder tree the Dryad held her home,  
And from the urn the gentle Naiad poured  
The wavelet’s silver foam.”

#### THE THREE REGIONS OF THE WORLD.

In the northern part of the world was supposed to be an underground, cold, and gloomy region, the “Nifheimr,” the mist-world, the land of the shadows, the abode of the departed; far down in the south was the fiery “Muspellsheimr,” and between them was the home of man, “Miðgaðr” (O.S. Middilgard), the Middle-Garden. In heaven is the dwelling of the gods, the lordly castle of Valhalla.

However gloomy and joyless Nifheimr was supposed to be, it is never mentioned as a place of punishment or torment. Everybody who dies of sickness or old age, whether good or wicked, goes there, but those who fall in battle are borne up by the Valkyries to Valhalla, where they lead the lives of heroes in bliss. Every morning they cover each other with wounds, which, however, heal at once, and they go home to seat themselves with Wodan at the banquet, where the beautiful Valkyries attend and serve them with wine.

#### WANING OF THE GODS AND END OF THE WORLD.

But this state of things is not destined to last for ever. At last comes the “*ragna rök*”—that is to say, twilight, or night of the gods, the “Götterdämmerung,” or Waning of the Gods. Then the gods must engage, in their last struggle against the powers of darkness and evil. The devouring flame will come out of Muspellsheimr, and will consume the world; the sun blackens, and the earth sinks into the abyss. This is the Muspilli, a sort of doomsday, on which even the gods are to perish, for they are not without sin.

But the earth is destined to rise again out of the sea in renewed beauty and verdure; then corn shall grow without being sown, all

evil shall be destroyed, men shall live in everlasting bliss, and gods without stain of sin shall reign for ever and ever.

The Norse mythology, as described in the Edda, is even more fantastic than the account I have given. But I am afraid that my description has already outrun and added to the religious conceptions of our Teutonic forefathers at the early date of which we are now speaking.

And here I must end. The period into which we have tried to get some glimpses is the childhood of our race, the remembrance of which is only preserved in dim and legendary form. Our race, however, soon entered into struggles which were destined to bring it to maturity: the fight for home and national existence in the times of the great "*Völkerwanderung*," and the inner struggles of their old religion against Christianity. And out of that period of strife and ferment they came with a wealth of beautiful memories, and with a Christian faith, that laid the foundation of their future development.

[EDITORIAL NOTE.—It is perhaps desirable to state that several matters have been slightly enlarged on, or fresh data introduced into this paper while passing through the press, so as to make it as complete as possible.—J. M.]

XVIII. — *On Electrical Oscillations.* By OLIVER J. LODGE,  
D.Sc., LL.D., F.R.S., Professor of Physics in University  
College, Liverpool.

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[Summary of Lecture delivered to the Society in the Natural Philosophy  
Class-Room, University of Glasgow, 16th April, 1890.]

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(THE following may serve as an introduction to the subject of the lecture, which might also have been called "The Modern Theory of Light.")

To persons occupied in other branches of learning, and not directly engaged in the study of Physical Science, some rumour must probably have travelled of the stir and activity manifest at the present time among the votaries of that department of knowledge.

It may serve a useful purpose if I try and explain to outsiders what this stir is mainly about, and why it exists. There is a proximate, and there is an ultimate, cause. The proximate cause is certain experiments exhibiting in a marked and easily recognisable way the already theoretically predicted connexion between electricity and light. The ultimate cause is that we begin to feel inklings and foretastes of theories, wider than that of gravitation, more fundamental than any theories which have yet been advanced; theories which, if successfully worked out will carry the banner of physical science far into the dark continent of metaphysics, and will illuminate with a clear philosophy much that is at present only dimly guessed. More explicitly, we begin to perceive chinks of insight into the natures of Electricity, of Ether, of Elasticity, and even of Matter itself. We begin to have a kinetic theory of the physical universe.

We are living, not in Newtonian, but at the beginning of a perhaps still greater Thomsonian, era,—greater, not because any one man is probably greater than Newton, but because of the stupendousness of the problems now waiting to be solved. There are a dozen men of great magnitude, either now living or but recently deceased, to whom what we now know towards these generalisations is in some measure due, and the epoch of complete

development may hardly be seen by those now alive. It is proverbially rash to attempt prediction, but it seems to me that it may well take a period of fifty years for these great strides to be fully accomplished. If it does, and if progress goes on at anything like its present rate, the aspect of physical science bequeathed to the latter half of the twentieth century will indeed excite admiration, and, when the populace are sufficiently educated to appreciate it, will form a worthy theme for poetry, for oratorios, and for great works of art.

To attempt to give any idea of the drift of progress in all the directions which I have hastily mentioned, to attempt to explain the beginnings of the theories of Elasticity and of Matter, would take too long and might only result in confusion. I will limit myself chiefly to giving some notion of what we have gained in knowledge concerning Electricity, Ether, and Light. Even that is far too much; I find I must confine myself principally to light, and only treat of the others as incidental to that.

For now well-nigh a century we have had a wave theory of light; and a wave theory of light is quite certainly true. It is directly demonstrable that light consists of waves of some kind or other, and that these waves travel at a certain well-known velocity, seven times the circumference of the earth per second, taking eight minutes on the journey from the sun to the earth. This propagation in time of an undulatory disturbance necessarily involves a medium. If waves setting out from the sun exist in space eight minutes before striking our eyes, there must necessarily be in space some medium in which they exist and which conveys them. Waves we cannot have unless they be waves in something.

No ordinary medium is competent to transmit waves at anything like the speed of light, hence the luminiferous medium must be a special kind of substance, and it is called the ether. The *luminiferous* ether it used to be called, because the conveyance of light was all it was then known to be capable of; but now that it is known to do a variety of other things also, the qualifying adjective may be dropped.

What properties are essential to a medium capable of transmitting wave motion? Roughly we may say two: *elasticity* and *inertia*—elasticity in some form, or some equivalent of it, in order to be able to store up energy and effect recoil; inertia, in order to enable the disturbed substance to overshoot the mark and

oscillate beyond its place of equilibrium to and fro. Any medium possessing these two properties can transmit waves, and unless a medium possesses these properties in some form or other, or some equivalent for them, it may be said with moderate security to be incompetent to transmit waves. But if we make this latter statement one must be prepared to extend to the terms elasticity and inertia their very largest and broadest signification, so as to include any possible kind of restoring force, and any possible kind of persistence of motion, respectively.

These matters may be illustrated in many ways, but perhaps a simple loaded lath or spring in a vice will serve well enough. Pull aside one end, and its elasticity tends to make it recoil; let it go, and its inertia causes it to over-shoot its normal position; both causes together incite it to swing to and fro till its energy is exhausted. A regular series of such springs at equal intervals in space, set going at regular intervals of time one after the other, gives you at once a wave motion and appearance which the most casual observer must recognise as such. A series of pendulums will do just as well. Any wave-transmitting medium must similarly possess some form of elasticity and of inertia.

But now proceed to ask—What is this Ether which in the case of light is thus vibrating? What corresponds to the elastic displacement and recoil of the spring or pendulum? What corresponds to the inertia whereby it overshoots its mark? Do we know these properties in the ether in any other way?

The answer, given first by Clerk Maxwell, and now reiterated and insisted on by experiments performed in every important laboratory in the world, is:—

The elastic displacement corresponds to electrostatic charge (roughly speaking, to electricity).

The inertia corresponds to magnetism.

This is the basis of the modern electromagnetic theory of light. Now let me illustrate electrically how this can be.

The old and familiar operation of charging a Leyden jar—the storing up of energy in a strained dielectric—any electrostatic charging whatever—is quite analogous to the drawing aside of our flexible spring. It is making use of the elasticity of the ether to produce a tendency to recoil. Letting go the spring is analogous to permitting a discharge of the jar—permitting the strained dielectric to recover itself—the electrostatic disturbance to subside.

In nearly all the experiments of electrostatics ethereal elasticity is manifest.

Next consider inertia. How would one illustrate the fact that water, for instance, possesses inertia—the power of persisting in motion against obstacles—the power of possessing kinetic energy? The most direct way would be, to take a stream of water and try suddenly to stop it. Open a water tap freely and then suddenly shut it. The impetus or momentum of the stopped water makes itself manifest by a violent shock to the pipe, with which everybody must be familiar. This momentum of water is utilised by engineers in the “water-ram.”

A precisely analogous experiment in Electricity is what Faraday called “the extra current.” Send a current through a coil of wire round a piece of iron, or take any other arrangement for developing powerful magnetism, and then suddenly stop the current by breaking the circuit. A violent flash occurs if the stoppage is sudden enough, a flash which means the bursting of the insulating air partition by the accumulated electromagnetic momentum.

Briefly, we may say that nearly all electromagnetic experiments illustrate the fact of ethereal inertia.

Now return to consider what happens when a charged conductor (say a Leyden jar) is discharged. The recoil of the strained dielectric causes a current, the inertia of this current causes it to overshoot the mark, and for an instant the charge of the jar is reversed; the current next flows backward and charges the jar up as at first; back again flows the current, and so on, charging and reversing the charge with rapid oscillations until the energy is all dissipated into heat. The operation is precisely analogous to the release of a strained spring, or to the plucking of a stretched string.

But the discharging body thus thrown into strong electrical vibration is imbedded in the all-pervading ether, and we have just seen that the ether possesses the two properties requisite for the generation and transmission of waves—namely, elasticity, and inertia or density; hence, just as a tuning fork vibrating in air excites aerial waves or sound, so a discharging Leyden jar in ether excites ethereal waves or light.

Ethereal waves can therefore be actually produced by direct electrical means. I discharge here a jar, and the room is for an instant filled with light. With light, I say, though you can see nothing. You can see and hear the spark, indeed; but that is a

mere secondary disturbance which we can for the present ignore : I do not mean any secondary disturbance. I mean the true ethereal waves emitted by the electric oscillation going on in the neighbourhood of this recoiling dielectric. You pull aside the prong of a tuning fork and let it go: vibration follows and sound is produced. You charge a Leyden jar and let it discharge : vibration follows and light is excited.

It is light, just as good as any other light. It travels at the same pace ; it is reflected and refracted according to the same laws ; every experiment known to optics can be performed with this ethereal radiation electrically produced, and yet you cannot see it, Why not ? For no fault of the light, the fault (if there be a fault), is in the eye. The retina is incompetent to respond to these vibrations—they are too slow. The vibrations set up when this large jar is discharged are from a hundred thousand to a million per second, but that is too slow for the retina. It responds only to vibrations between 400 billion and 700 billion per second. The vibrations are too quick for the ear, which responds only to vibrations between 40 and 40,000 per second. Between the highest audible and the lowest visible vibrations there has been hitherto a great gap, which these electric oscillations go far to fill up. There has been a great gap simply because we have no intermediate sense organ to detect rates of vibration between 40,000 and 4,000,000,000,000,000 per second. It was therefore an unexplored territory. Waves have been there all the time in any quantity, but we have not thought about them nor attended to them.

It happens that I have myself succeeded in getting electric oscillations so slow as to be audible ; the slowest I have got up to the present are 125 per second, and for some way above this the sparks emit a musical note ; but no one has yet succeeded in directly making electric oscillations which are visible,—though indirectly everyone does it when he lights a candle.

Here, however, is an electric oscillator which vibrates 300 million times a second, and emits ethereal waves a yard long. I have also succeeded in getting them as short as three inches. The whole range of vibrations between musical tones and some thousand million per second, is now filled up. There is still a gap between the shortest of these waves and the longest solar waves detected by the photometer or radio-micrometer—namely, about the three-hundredth of an inch : but it is a great deal narrower gap than it used to be.

These electromagnetic waves have long been known on the side of theory, but interest in them has been immensely quickened by the discovery of a receiver or detector for them. The great though simple discovery by Hertz of an "electric eye," as Sir W. Thomson calls it, makes experiments on these waves for the first time easy or even possible. We have now a sort of artificial sense organ for their appreciation—an electric arrangement which can virtually "see" these intermediate rates of vibration.

The Hertz receiver is the simplest thing in the world—nothing but a bit of wire, or a pair of bits of wire, adjusted so that when immersed in strong electric radiation they give minute sparks across a microscopic air gap.

The receiver I have here is adapted for the yard-long waves emitted from this small oscillator; but for the far longer waves emitted by a discharging Leyden jar an excellent receiver is a gilt wall-paper or other interrupted metallic surface. The waves falling upon the metallic surface are reflected, and in the act of reflexion excite electric currents, which cause sparks. Similarly, gigantic solar waves may produce auroræ; and minute waves from a candle do electrically disturb the retina.

The smaller waves are, however, far the most interesting and the most tractable to ordinary optical experiments. From a small oscillator, which may be a couple of small cylinders or spheres kept sparking into each other by an induction coil, waves are emitted on which all manner of optical experiments can be performed.

They can be reflected by plain sheets of metal, concentrated by parabolic reflectors, refracted by prisms, concentrated by lenses. I have at the College, in Liverpool, a large lens of pitch, weighing over three hundredweight, for concentrating them to a focus. They can be made to show the phenomenon of interference, and thus have their wave-length accurately measured. They are stopped by all conductors and transmitted by all insulators. Metals are opaque, but even imperfect insulators such as wood or stone are strikingly transparent, and waves may be received in one room from a source in another, the door between the two being shut.

The real nature of metallic opacity and of transparency has long been clear in Maxwell's theory of light, and these electrically-produced waves only illustrate and bring home the well-known facts. The experiments of Hertz are, in fact, the apotheosis of that theory.

Light is an electromagnetic disturbance of the ether. Optics is a branch of electricity. Outstanding problems in optics are being rapidly solved, now that we have the means of definitely exciting light with a full perception of what we are doing, and of the precise mode of its vibration.

It remains to find out how to shorten down the waves—to hurry up the vibration until the light becomes visible. Nothing is wanted but quicker modes of vibration. Smaller oscillators must be used—very much smaller,—oscillators not much bigger than molecules. In all probability—one may almost say certainly—ordinary light is the result of electric oscillation in the molecules of hot bodies, or sometimes of bodies not hot—as in the phenomenon of phosphorescence.

The direct generation of *visible* light by electric means so soon as we have learnt how to attain the necessary frequency of vibration, will have most important practical consequences.

In illustration of these propositions a number of experiments were shown. A U-tube of water was employed to illustrate the elementary facts of electric oscillation, when the charge on a body was disturbed and allowed to equilibrate itself in a sudden manner; and a Leyden jar was shown overflowing by sudden recoil, just as water in a bath does when tilted and suddenly let go. Corresponding to the well-known experiment of a couple of resounding tuning forks, an experiment of resounding Leyden jars was shown, when the discharge of one jar excited and made overflow another jar similarly tuned to it. The rate of vibration in this case was about half-a-million a second, and the waves were about 70 yards long; but by using much smaller jars and shorter discharging circuits the rate of vibration could be much increased, and the waves rendered proportionately shorter.

The lecturer then exhibited a Hertz vibrator excited by a Ruhmkorf coil, and explained the rapid fading away of the vibrations, pointing out that the energy of these vibrations was due principally to the emission of the waves into the surrounding medium. It was the ether itself that took up nearly the whole of the energy and transmitted it forward into space. He reckoned in the case before him that the radiation was about 100 horse-power. For the comparison of these vibrations with the vibration of light, he said they had been submitted to every test which had been applied to luminous vibrations. They had been reflected by

metallic surfaces, they had been refracted through lenses, for which purpose great lenses of pitch had been used. There had also been obtained interference phenomena, and, lastly, the phenomena of polarisation. Returning to the question of the shortening of vibrations, the lecturer showed spheres of different sizes, and explained that the time of oscillation of electric disturbance on a metallic sphere was equal to the time taken by light to travel 1.4 times the diameter of the sphere. By using brass balls of small diameter he had been able to obtain waves of not greater length than three inches.

Although they could not realise it, they could imagine passing on to vibrations of electricity in the molecules of matter, and in this connection he exhibited a very beautiful phosphorescent vacuum tube (sent him by Dr. Lenard of Heidelberg), in which there were strontic sulphide, a little fluor spar, and a trace of copper. An electric charge was passed over the powder in the tube, which emitted a brilliant green light; and the lecturer said he believed this would become the light of the future, although there was in the present case a light of only half a candle power.

The lecturer concluded by exhibiting an arrangement of conducting lines on the surface of a glass plate, which lines he compared to the rods and cones in the retina of the eye. He exhibited also a series of brass cylinders of different diameters, which responded severally to their appropriate waves by diametral electric vibration. He imagined the rods and cones to be tuned to receive the luminous vibrations as the cylinders were tuned to receive the electric vibrations. So it seemed that they had there the beginnings of a theory of vision. According to it the rods and cones constituted a sort of Corti's organ, and the different colour sensations corresponded to the different diameters of the retinal bodies. There was much yet to be worked out, and in particular the doctrine of these primary colour sensations appeared to become on this view somewhat strained and improbable; unless, indeed, physiologists were able to find three distinct sizes or kinds of rods and cones in the retina. Physically it was certain that three colour sensations were sufficient to explain normal vision, but physiologically it had to be shown that no more than three actually existed. The electric theory of vision at first sight appeared to lend itself more simply to a doctrine of an infinite number of colour sensations, corresponding to the infinite series of the visible spectrum.

The subject of electro optics had hitherto been a somewhat narrow field (among the workers in which, by the way, one of the citizens of Glasgow, Dr. Kerr, stood eminent); but in the light of recent work, this narrow field showed signs of opening into a wide and fertile region, offering easy returns for a moderate outlay of calculation and experiment.

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The President (Professor M'Kendrick), at the close of the lecture, said they had been in the habit of saying that we had no electric organ, no instrument by which we could detect electric phenomena; but after the explanations which they had had that night, they began to see that that was an artificial way of treating the matter, that what were called light waves were short electric waves, and that we had an organ which could detect these waves which we had been in the habit of talking of as light. The electric origin of sight, he had no doubt, would receive the careful attention of physiologists.

Sir William Thomson said the ancients had what had been called the music of the spheres. Dr. Lodge had given the meeting what might be called the music of the ether. He well remembered when the subject of electrical oscillation began first to grow in the minds of those who had been thinking of it. This was at the meeting of the British Association at Southport. The question was put before the members in an informal discussion, and they were asked to think of waves quicker than the shortest audible waves of sound which correspond to 10,000 or 20,000 periods per second. At that meeting Fitzgerald hazarded the bold opinion that electric oscillations might fill up the gap between the highest audible vibrations of 20,000 per second, and the lowest luminous vibrations of 100 million million per second. The researches of Hertz and Lodge had realised what was then nothing more than a splendid speculation.

Professor Lodge thanked the audience for their attention, and said he desired to return his special thanks to Sir Archibald Campbell (who was present) for the great assistance he had given by lending apparatus, and helping in the preparations for the evening's lecture. The electrical machine that had been used was one that had been constructed by Sir Archibald, who presented it to the University some months ago.

## REPORTS OF SECTIONS.

SESSION 1889-90.

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[Received at Meeting of Society on 30th April, 1890.]

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### 1. REPORT OF ARCHITECTURAL SECTION.

During the Session eight Meetings have been held, at which eight papers have been read. The following is a list of the papers read, with dates of Meetings :—

*Monday, 18th November, 1889.*—Opening Meeting, when Mr. James Thomson, architect, F.R.I.B.A., President of the Section, gave his address.

*Monday, 2nd December, 1889.*—Mr. Alexander Muir, builder, read a paper on “Impressions of Australia, Naples, Pompeii, &c.”

*Monday, 16th December, 1889.*—Mr. Alexander Frew, C.E., read a paper on “The Reclamation of Waste Lands on the Clyde Estuary considered in relation to the disposal of the Sewage of Glasgow.”

*Monday, 20th January, 1890.*—Mr. Stephen Adam, glass stainer, read a paper on “The Progress of Stained Glass in recent years.”

*Monday, 3rd February, 1890.*—Mr. Robert J. Bennett, painter and decorator, read a paper on “Interior Decoration, Past and Present.”

*Monday, 17th February, 1890.*—Mr. D. M'Lellan, Superintendent of Public Parks, read a paper on “Horticulture: its Progress; with a few observations on Villa Gardening and Open Spaces in large cities and centres of industry.”

*Monday, 3rd March, 1890.*—Mr. William Leiper, architect, read a paper on “Reminiscences of some Italian Towns.”

*Monday, 17th March, 1890.*—Mr. John Keppie, architect, read a paper on “Accessories of Architecture.”

The thanks of the Section are due to all these gentlemen.

During the Session 16 Associates joined the Section.

The Annual Business Meeting was held on Monday, 17th March, when the Council was reconstituted.\*

(Signed) A. LINDSAY MILLER, *Architect*,  
*Hon. Secy. of Section*,  
 121 WEST REGENT STREET.

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## 2. REPORT OF THE GEOGRAPHICAL AND ETHNOLOGICAL SECTION.†

Three papers from the Section were read before the Society during the Session: (1) "The Territorial Expansion of the British Empire during the past ten years," by Dr. Thomas Muir, President of the Section, on 11th December, 1889; (2) "Some consideration of the Ethnology of Asia Minor," by Rev. Hugh Callan, M.A., on 28th April, 1890; (3) "Fiji: Past and Present," by Mr. James Blyth, late Secretary for Native Affairs, Fiji, also on 28th April. They will all be printed in the *Proceedings*. Two other Meetings were held under the arrangement for holding joint Meetings with the Glasgow Branch of the Royal Scottish Geographical Society, at which the following papers were read:—(1) "Light and Liberty for Africa: Britain's Spheres of Influence considered Geographically," by General Sir Lewis Pelly, K.C.B., on 29th November, 1889; and (2) "Scandinavia: The Vikings and the Geography of their Times," by Mr. Paul du Chaillu, on 15th April, 1890.

(Signed) GEO. A. TURNER, M.D.,  
*Secretary*.

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## 3. REPORT OF THE BIOLOGICAL SECTION.

No Report was received from this Section owing to illness of Secretary.

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## 4. REPORT OF THE MATHEMATICAL AND PHYSICAL SECTION.

The Section held no Meeting of its own during the Session. There is only one Associate, so that the only object of the existence of the Section is to contribute papers on subjects covered

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\* See Page 252.

† For list of Office-Bearers, see p. 255.

by its title. Several papers obtained through the Section were read at the Ordinary Meetings of the Society, and are printed in the *Proceedings*.

MAGNUS MACLEAN,  
*Secretary.*

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#### 5. REPORT OF THE CHEMICAL SECTION.

The Chemical Section of the Society is still in the same condition as regards Membership and Meetings as reported last Session. The only contribution under its auspices was that by Professor A. Crum Brown, D.Sc., F.R.S.—the “Graham” Lecture, on March 5th—Subject, “The Basicity of Acids.” The lecturer traced the development of our knowledge of this important subject from the earliest observations of Graham to the present time; and his elaborate and carefully prepared paper forms a most valuable contribution to the *Proceedings* of the Society.

It is proposed that the Graham Medal should be awarded next Session.

JOHN TATLOCK,  
*Secretary.*

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#### 6. REPORT OF SANITARY AND SOCIAL ECONOMY SECTION.

A Meeting of the Section was held on Wednesday Evening, 6th November, 1889, at which the Office-bearers for the Session were elected.\*

No papers have been read before the Society this winter.

(Signed) W. R. M. CHURCH, C.A.,  
*Hon. Secretary,*  
75 ST. GEORGE'S PLACE.

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#### 7. REPORT OF ECONOMIC SCIENCE SECTION.

The following Papers have been read during the Session:—

*December 4, 1889*—“How the Problem of Housing the Poor has been solved in London.” Read before the Society by Mr. Wm. Smart, M.A.

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\* See Page 255.

*December* 18, 1889—"The Economic Aspect of the London Dockworkers' Strike." Before the Society by Mr. H. Llewellyn Smith, B.A., B.Sc.

*February* 27, 1890—"Notes on Compromise in Wages Disputes." Before the Section by Mr. W. Craig Ramsay, S.S.C.

*April* 2, 1890—"The Incidence of Local Taxation." Before the Society by Mr. Robert Hill, W.S., Solicitor to the Caledonian Railway.

WALTER W. BLACKIE,  
*Hon. Secy. of Section.*

#### 8. REPORT OF PHILOLOGICAL SECTION.

During the Session there have been no Sectional Meetings, but two of the Members read papers before the Society, namely:—

Dr. Fiedler on "Some Glimpses into Teutonic Antiquity."

Rev. Prof. Robertson on "The Trade Guilds of Damascus."

Both papers were highly appreciated for their presentation of interesting philological facts.

The Secretary was disappointed in securing the other contributions that had been promised.

In accordance with the instructions of the Committee, Prof. Jebb was asked to retain the Presidentship on his removal to Cambridge. In his reply he most cordially accepted the post and thanked the Members for the honour they had conferred upon him.

At a Meeting held in the Society's Rooms, on 25th October, 1889, the Committee and Office-bearers of the previous Session were re-elected with certain changes.\*

Up to this date only two Associates have paid their subscriptions for the Session.

JAMES COLVILLE, M.A., D.Sc.,  
*Hon. Secy. and Treas.*

\* The list is given at p. 256.

REPORT OF DELEGATE TO BRITISH ASSOCIATION MEETING,  
NEWCASTLE, 1889.

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[Received at Meeting of Society on 30th April, 1890.]

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Delegates sent by provincial societies to the British Association are not intended to make any general report as to what has been done at the meetings of the Association; their function is to attend the Conference of Delegates of corresponding societies, and to represent their own society there. The purpose of these conferences is, as I have explained in a previous report: (1) To secure co-operation amongst scientific societies scattered over the kingdom and generally disconnected with each other; (2) to suggest to these societies investigations which can be satisfactorily carried out only under a common plan; and (3) to call the attention of the members of these societies to subjects on which they could supply information or make researches. The aim, therefore, of these conferences in promoting scientific intercourse and in preventing much dissipation of scientific energy is excellent, and through their suggestions much useful work will be done.

Thirty-five delegates attended the meetings at Newcastle.

The following brief notice of the various matters reported on and discussed at the conference may, and I trust will, be useful in directing the attention of members of the Philosophical Society to subjects on which many of them could make investigations with pleasure to themselves and good in advancing knowledge.\*

PHYSICS.

*Temperature Variation of Lakes, Rivers, and Estuaries.*—The object of the committee is to accumulate as great a mass of data, with regard to the temperature of the surface of lakes, rivers, and estuaries, and the sea near the shore, as could possibly be obtained, in order to discuss this in connection with the meteorology of the country. It is found, for example, that in some rivers the temperature rises after rain, while in others it falls suddenly during rain. Observations in more places are desired, and the requisite apparatus is cheap. Full particulars as to taking observations can

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\* I append the names and addresses of some secretaries of committees, with whom those desirous of taking up these investigations would do well to put themselves in communication.

be obtained from Professor Lebour, College of Science, Newcastle-on-Tyne.

#### GEOLOGY.

*Sea-Coast Erosion.*

*Underground Waters.*

*The Position and Character of Erratic Boulders.*

*Earth Tremors.*

See previous report to Philosophical Society (*Proc. Phil. Soc., Glas., vol. xix., p. 374*), nothing new having been communicated to the conference on these matters since then.

*Geological Photography.*—The chief object at present is to get photographs of typical and especially of *temporary* sections. Whole-plate photographs (12 by 10 inches) are preferred, but this size is not essential. The name and position of the locality or section, including compass directions, are to be given, and an illustrative diagram or sketch of the details should accompany the photographs.

#### BIOLOGY.

*Life-Histories of British Plants.*—This subject was brought before the meeting of delegates in 1887 by Prof. I. B. Balfour. He has since published a long letter giving suggestions to those who wish to make systematic observations. The general idea is that local naturalists, instead of hunting rare wild plants, would do well to observe the evolution of selected plants from the seed onwards—to study, in fact, the post-embryonary evolution of plants. Prof. Balfour's letter should be consulted by botanists. It is printed in *Nature*, 20th December, 1888, and in the Report of British Association, 1889.

*Investigation of the Invertebrate Fauna and Cryptogamic Flora of the British Islands.*—It is desired to make a systematic investigation of rivers and lakes, and it is hoped that microscopists will undertake definite scientific work. Prof. Cossar Ewart, Edinburgh University, is secretary of this committee, and he will give any information that may be needed by those willing to undertake such investigations.

#### MECHANICS.

*Flameless Explosives.*—The properties of these should be examined to see whether they are really flameless or not, so that miners may not make use of those that are not what they are represented to be.

*Fan Ventilation.*—It would be of great use to miners, if members of mining and engineering societies would observe the working of different kinds of fans in the same pit. The committee desired to have communications on this subject.

ANTHROPOLOGY.

*Exploration of Barrows and other Antiquarian Remains.*—Much injury is done to these objects by injudicious explorations. A committee has been formed to aid by giving a series of directions to those who desire to explore barrows and other ancient remains. The committee wish it to be understood that “they did not want to interfere in any way, or to take the credit of any work undertaken. They only wanted to have the work performed to the best advantage.” Communications as to “finds” or explorations should be made to the secretary of the Anthropological Institute, 3 Hanover Square, London.

W. C. CRAWFORD.

## MINUTES OF SESSION.

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*6th November, 1889.*

The Philosophical Society of Glasgow held its First Meeting for Session 1889-90, on the Evening of Wednesday, 6th November, 1889, at Eight o'clock, in the Society's Rooms, 207 Bath Street—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of Meeting held on 1st May, 1889, which had been printed in Vol. XX. of the Society's *Proceedings*, now in the hands of the Members, were held as read, were approved of, and signed by the Chairman.

2. Dr. Russell delivered the Opening Address, his subject being "Sanitation and Social Economics: an Object-Lesson." At the close he was awarded the thanks of the Society, on the motion of Dr. Ebenezer Duncan.

3. Mr. Wm. Lang, jun., F.C.S., President of the Glasgow Photographic Association, exhibited two volumes of Photographic Reproductions by the Cyanotype Process (executed about thirty years ago), and made some remarks upon the process. A short discussion ensued, the speakers being Mr. Mechan, Mr. Robert Blackie, Mr. Annan, and Mr. James Thomson. On the motion of the President, the thanks of the Society were awarded to Mr. Lang for his communication.

4. Mr. Robert Blyth, C.A., and Mr. James Barclay were appointed to audit the Treasurer's accounts for the year 1888-89.

5. The President announced that the following Candidates for admission into the Society had been elected:—Mr. Robert Ramsay, wool broker, 14 Park Terrace; Mr. James Kennedy, hide and wool broker, 33 Greendyke Street; Mr. R. A. Inglis, Arden, Bothwell; Mr. John Dunlop Parker, C.E., 146 West Regent Street; Mr. John S. MacArthur, 13 West Scotland Street; Dr. George Halket, 4 Royal Crescent; Mr. T. B. Fotheringham, timber importer, 65 West Regent Street; Mr. William Smith, jun., 1 University Gardens Terrace, Hillhead; Mr. Leonard Gow,

19 Waterloo Street; Mr. William S. Hunter, grain merchant, 30 Hope Street; and Mr. A. Y. Fraser, M.A., F.R.S.E., Allan Glen's School.

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*20th November, 1889.*

The Annual General Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 20th November, 1889, at Eight o'clock—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of the First Ordinary General Meeting for Session 1889-90, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. Robert Ramsey, Mr. James Kennedy, Mr. R. A. Inglis, Mr. John Dunlop Parker, C.E., Mr. John S. MacArthur, Dr. George Halket, Mr. T. B. Fotheringham, Mr. William Smith, jun., Mr. Leonard Gow, Mr. William S. Hunter, and Mr. A. Y. Fraser, M.A., F.R.S.E., were admitted to the Membership of the Society.

3. The Annual Report by the Council on the State of the Society having been printed in the Billet convening the Meeting, was held as read, and its adoption was moved from the Chair. Dr. Mackinlay made some remarks on several items of the Report, which were replied to by the Chairman, Mr. Alexander Scott, the Treasurer, and the Librarian. The motion to approve of the Report was subsequently adopted. The Report is subjoined :—

#### REPORT OF COUNCIL FOR SESSION 1888-89.

1. *Meetings.*—The opening meeting of Session 1888-89 was held on 7th November, 1888, and on 1st May, 1889, the Session closed. During that period fourteen meetings took place, one of which was held on 10th April in the Natural Philosophy Class-Room at the University, on which occasion communications, experimentally illustrated, were made to the Society by Sir William Thomson and Mr. J. T. Bottomley. The communications made to the Society during the Session amounted to twenty-nine, of which twenty-four are published, either in full or in abstract, in Vol. XX. of the *Proceedings* of the Society. There were also three meetings held jointly by the Philosophical Society and the Glasgow Branch of the Royal Scottish Geographical Society.

II. *Membership*.—The number of Ordinary Members on the Roll at the beginning of Session 1888-89 was 642. During the Session 21 new Members were admitted, making 663. Of these 19 have resigned, 13 have died, 2 have left Glasgow and their names have been placed on the Suspense List, and 6 have been struck off the Roll for non-payment of subscriptions—leaving on the Roll at the beginning of the present Session 623 Members, being a decrease of 19. Of the 21 New Members, 1 became a Life Member. There are now 102 Life Members. Four vacancies exist in the list of Honorary Members. There are at present 16 Honorary Members, of whom 5 are Continental, 3 are American or Colonial, and 8 are British. The number of Corresponding Members is 10. The Membership of the Society, then, is as follows:—Honorary Members, 16; Corresponding Members, 10; Ordinary Members, 623; or a total of 649.

III. *Sections*.—(1) The *Architectural Section* held eight meetings during the Session, at which, in addition to the President's Opening Address, seven papers were read. One of these is published in the *Proceedings*.

(2) No meetings of the *Chemical Section* were held during the Session, but the Associates were invited to the periodical meetings of the Glasgow and Scottish Branch of the Society of Chemical Industry, which were also notified to the members of the Society generally.

(3) All the papers from the *Sanitary and Social Economy Section* were read before general meetings of the Society. In the *Proceedings* will be found the Opening Address of the President of the Section, a paper in full, and abstracts of other two papers.

(4) Through the *Geographical and Ethnological Section* one paper was communicated to the Society and is published in the *Proceedings*.

(5) Three papers from the *Biological Section* were read at one of the general meetings of the Society. They all appear in the *Proceedings*, one of them somewhat abbreviated.

(6) Four communications were received from the *Mathematical and Physical Section*, one of which is published in the *Proceedings*.

(7) The *Economic Science Section* held seven meetings during the Session, at which six papers were read. Three of the papers are given in the *Proceedings*.

(8) Professor R. C. Jebb, in his capacity of President, formally inaugurated the *Philological Section* in the course of the Session, by delivering an address at a general meeting of the Society. It is published in the *Proceedings*, as is likewise a paper read by the Secretary of the Section. Two separate meetings of the Section were held, at which three papers were read.

(9) It may be proper to mention that the Secretaries of several of the Sections have been useful in adding to the Membership of the Society—although at the expense of the lists of Associates of their respective Sections.

IV. *Proceedings*.—Vol. XX. of the Society's *Proceedings* is now in the hands of the Members. The volume may be regarded as highly creditable to the Society, on account of the scientific value of a large portion of the

contents. There are in all thirty communications—addresses, papers, and abstracts. Much to the regret of the Council, no fewer than four of these communications have been called forth by the deaths of valuable and much-esteemed Members of the Society—namely, Dr. Wallace, Mr. Coleman, Mr. E. M. Dixon, and Mr. James Sellars. The contents of the volumes are illustrated by means of twenty-five figures, distributed through the text, and by seven plates, one of which is a map of Chile.

V. *General Index to Proceedings*.—Progress is being made in the preparation of the General Index to the twenty volumes of the Society's *Proceedings* now published.

VI. *Contagious Diseases in Day Schools*.—The Committee which Dr. Finlayson suggested in his paper on this subject was appointed, and will proceed to work as soon as the School Boards and other Educational Bodies have chosen their respective representatives.

VII. *Finance*.—The Treasurer's Statement opened with a balance on hand of £20 4s. 5d., and closed with a Balance in Bank and on hand of £65 14s. 1½d., which shows an improvement in the Funds, during the year, of £44 9s. 8½d. It will be observed that the Statement is presented so as to show the Income and Expenditure comparatively with those of the previous year.

By order and on behalf of the Council.

(Signed) JOHN MAYER,  
Secretary.

4. The Treasurer's audited Statement of the Funds of the Society, which had also been printed in the Billet, was next submitted by the Chairman, and its adoption was unanimously agreed to. The Abstract of Treasurer's Account of the Graham Medal and Lecture Fund, and that of the Science Lectures Association Fund, were also submitted. These financial Statements are subjoined :—

(See *Financial Statements*, pp. 236-239.)

5. Mr. JOHN ROBERTSON, on behalf of the Library Committee, submitted the Report on the State of the Library. Its adoption was agreed to, and, on the motion of Mr. Robertson, the thanks of the Society were awarded to the donors of Books to the Library during the year. The Report was as follows :—

#### REPORT OF THE LIBRARY COMMITTEE.

During last year 39 volumes, 9 parts of works and 19 pamphlets were presented to the Library, while 18 volumes and 183 parts were received in exchange from 162 Societies and Public Departments. There were purchased 36 volumes and 5 parts. In order to enable the Treasurer to adjust the expenditure of the Society to the income, no books were bought since

(Continued on page 240.)

## Dr. ABSTRACT OF TREASURER'S ACCOUNT—SESSION

	1888-89.	1887-88.
To BALANCE in Treasurer's hands from last year, . . .	£20 4 5	
„ SUBSCRIPTIONS to 31st October, 1889—		
Entry-money at 21s., . . . . . £22 1 0		£51 9 0
Annual Dues at 21s.—		
Arrears, . . . . . £9 9 0		
For 1888-89, 515 Ordinary Members, . . . . . 533 8 0		
„ „ 20 New Members, 21 0 0		
	563 17 0	596 8 0
Life Subscription at £10 10s.—		
6 Old Members, . . . . . £63 0 0		
1 New „ . . . . . 10 10 0		
	73 10 0	52 10 0
	659 8 0	£700 7 0
„ GENERAL RECEIPTS—		
Corporation of Glasgow, Interest on “Exhibition Fund,” £451 17s. at $4\frac{1}{2}\%$ for half-year to Martinmas, 1888—less Income Tax, . . . . . £9 18 3		19 14 10
Bank Interest, . . . . . 3 8 0		1 7 2
Proceedings, sold, . . . . . 0 15 3		4 19 3
	14 1 6	
„ ARCHITECTURAL SECTION—		
68 Associates' fees for 1888-89, at 5s., . . . . .	17 0 0	20 10 0
„ CHEMICAL SECTION—		
Associates' Fees, . . . . .	0 0 0	1 5 0
„ ECONOMIC SCIENCE SECTION—		
3 Associates' fees for 1887-88, at 5s., . . . . . £0 15 0		
36 Do. for 1888-89, at 5s., . . . . . 9 0 0		
	9 15 0	13 10 0
„ GEOGRAPHICAL AND ETHNOLOGICAL SECTION—		
2 Associates' fees for 1887-88, at 5s., . . . . . £0 10 0		
28 Do. for 1888-89, at 5s., . . . . . 7 0 0		
	7 10 0	9 5 0
„ MATHEMATICAL AND PHYSICAL SECTION—		
7 Associates' fees for 1888-89, at 5s., . . . . .	1 15 0	2 15 0
„ PHILOLOGICAL SECTION—		
8 Associates' fees for 1888-89, at 5s., . . . . .	2 0 0	0 0 0
	£731 13 11	£773 13 3

*Memo. by Treasurer.*—The Amount invested by the Society in the Bath Street Joint Buildings up to 31st October, 1889, is . . . . . £3,547 8 1½  
whereof, Paid from Society's Funds, . . . . . £2,047 8 1½  
Do. Society's half of £3,000 Bond, . . . . . 1,500 0 0

£3,547 8 1½

J. M.

1888-89, AND COMPARISON WITH SESSION 1887-88.

Cr.

	1888-89.	1887-88.
By BALANCE due Treasurer at 1st November, 1887, . . .	£0 0 0	£18 12 4½
„ GENERAL EXPENDITURE to 31st October, 1889—		
Salary to Secretary, . . . . . £75 0 0		75 0 0
Allowance for Treasurer's Clerks, . . . . . 15 0 0		15 0 0
Rent for Joint-Lectures with Scottish Geo- graphical Society, . . . . . 3 0 0		1 0 0
Expenses at Lectures, . . . . . 0 9 6		0 3 6
	93 9 6	
New Books & Periodicals, British & Foreign, £100 5 5		139 14 1
Bookbinding, . . . . . 55 11 2		10 7 0
Printing Circulars, <i>Proceedings</i> , &c., . . . . . 171 10 3		199 0 0
Lithographs and Woodcuts for <i>Proceedings</i> , &c., 14 7 6		38 2 2
Postage and delivery of Circulars, Letters, &c., 37 16 5½		44 0 9
Stationery, Diplomas, &c., . . . . . 7 19 2		4 11 3
	387 9 11½	
Fire Insurance on Library for £5,400, . . . . . £6 1 3		6 1 3
Postages, &c. per Secretary, £3; per Treasurer, £2 17s. 9d., . . . . . 5 17 9		6 14 11½
	11 19 0	
Joint Expenses of Rooms—Society's half of £380 13s. 1½d., being Interest on Bond, Insurance, Taxes, Cleaning, Repairs, Lighting, and Heating; Salaries of Sub- Librarian and Assistant (including Expenses of Transfer of Bond, £31 13s. 8d.), less half of £79 12s. 6d., Revenue from Letting, . . . . .	150 10 3½	163 17 6
„ SUBSCRIPTIONS TO SOCIETIES—		
Ray Society, 1889, . . . . . £1 1 0		
Palæontographical Society, 1889, . . . . . 1 1 0		
	2 2 0	2 2 0
„ ARCHITECTURAL SECTION—		
Expenses per Treasurer of Section, . . . . .	11 3 9½	9 14 0
„ ECONOMIC SCIENCE SECTION—		
Expenses per Treasurer of Section, . . . . . £0 15 4		
Special Printing in General Account, . . . . . 1 8 3		
	2 3 7	11 5 10
„ GEOGRAPHICAL AND ETHNOLOGICAL SECTION—		
Expenses per Treasurer of Section, . . . . . £1 7 6		
Special Printing in General Account, . . . . . 2 1 6		
	3 9 0	7 8 6
„ MATHEMATICAL AND PHYSICAL SECTION—		
Expenses per Treasurer of Section, . . . . .	0 1 6	0 1 2
„ PHILOLOGICAL SECTION—		
Expenses per Treasurer of Section, . . . . . £0 4 2		
Special Printing in General Account, . . . . . 2 16 6		
	3 0 8	0 0 0
„ SANITARY AND SOCIAL ECONOMY SECTION—		
Expenses per Treasurer of Section, . . . . .	0 10 6	0 12 6
„ BALANCES, viz. :—		
In Clydesdale Bank, . . . . . £60 0 0		
In Treasurer's hands, . . . . . 5 14 1½		
	65 14 1½	20 4 5
	<u>£731 13 11</u>	<u>£773 13 3</u>

GLASGOW, 16th November, 1889.—We, the Auditors appointed by the Society to examine the Treasurer's Accounts for the year 1888-89, have examined the same, of which the above is an Abstract, and have found them correct, the Balances being—in Clydesdale Bank Sixty Pounds, and in Treasurer's hands Five Pounds Fourteen Shillings and Three-halfpence.

(Signed)

ROBERT BLYTH, C.A.  
JAMES BARCLAY.

JNO. MANN, C.A., Treasurer.



# THE SCIENCE LECTURES ASSOCIATION FUND.

## ABSTRACT OF TREASURER'S ACCOUNT—SESSION 1888-89.

Gr.

Dr.

SCIENCE LECTURES ASSOCIATION—		CAPITAL AT 31ST OCT., 1889—
Capital Sum handed over to the Philosophical Society in Trust, per Deposit Receipt, - - -		Invested in £200 Caledonian Railway Coy. 4% Preference Stock No. 1, in name of the Philosophical Society in Trust, Cost, - £244 4 8
REVENUE—		On Deposit Receipt, - - -
Interest from Bank on Do., till invested, and on Balance uninvested, - - -		£252 10 0
Dividend, April, 1889, less Tax, - - -		
" Oct., " - - -		10 8 3
		£262 18 3
BALANCE, BEING REVENUE—		
On Deposit Receipt, - - -		10 8 3
		£262 18 3

GLASGOW, 16th November, 1889.—Examined and found correct.

JNO. MANN, C.A., Treasurer.

ROBERT BLYTH, C.A.  
JAMES BARCLAY.

last annual meeting. At present 101 periodicals are received at the Library. Of these 60 are bought and 41 presented. The total additions during the year amount to 198 volumes, 199 parts of works, and 19 pamphlets. The books in the Library were counted during the Session and found to reach the number of 10,667 volumes. During the year 254 volumes were bound, and 642 volumes were issued to 409 members.

Since last Report the following Societies have been added to the list of exchanges:—Manchester Literary and Philosophical Society, Natural History and Antiquarian Society of Dumfriesshire and Galloway, New York Microscopical Society, Royal Society of New South Wales, Scientific Society of Manitoba, and Trenton Natural History Society.

In Volume XX. of the *Proceedings*, pp. 367-374, will be found a list of the additions to the Library by purchase up to May, 1889, the titles of the books presented, with the names of the donors, the names of the Societies with which exchanges are made, and a list of the periodicals regularly received.

JOHN ROBERTSON, LIBRARIAN,  
*Convener.*

6. On the motion of the CHAIRMAN, the best thanks of the Society were awarded to the Treasurer and the Librarian for their services during the past year.

7. The Society then proceeded to the election of Office-Bearers:—

- (1) Dr. Russell stated that his term of office had now expired, and on behalf of the Council he moved the election of Dr. J. G. M'Kendrick as his successor. The motion was passed with acclamation. Dr. M'Kendrick then took the Chair as President of the Society. He briefly addressed the Meeting, and expressed his very cordial thanks for the honour conferred upon him.
- (2) On the recommendation of the Council, Mr. J. T. Bottomley, M.A., F.R.S., who had for the remainder of the late Mr. Coleman's term of office been acting as one of the Vice-Presidents, was now elected for the full term of three years and Dr. W. G. Blackie, F.R.G.S., was elected as Vice-President, in succession to Dr. M'Kendrick, for one year.
- (3) The President moved the re-election of Mr. Robertson as Librarian, Mr. Mann as Treasurer, and Mr. Mayer as Secretary, which was agreed to.
- (4) On the motion of Mr. William Milne, the following four Members were elected to serve on the Council for the full term of three years, namely:—Mr. William Lang, jun., F.C.S., Dr. James Colville, M.A., Professor James Blyth, M.A., F.R.S.E., and Councillor Mechan; and Mr. D. Sinclair, Engineer, National Telephone Company, was elected to serve for one year in succession to Mr. Bottomley.

- (5) Various Office-Bearers of the Geographical and Ethnological Section were appointed, according to Resolution of Society of 11th April, 1883; and on the motion of Dr. Turner, Secretary, seconded by Mr. Robert Gow, a very special vote of thanks was awarded to Dr. Blackie, President of the Section, who had retired, and was to be succeeded by Dr. Thomas Muir. There were also elected the Office-Bearers of the Chemical, Biological, Sanitary and Social Economy, Mathematical and Physical, and Economic Science Sections, in accordance with Resolution of Society of 18th November, 1885, and 2nd February, 1887. On the motion of Dr. Colville, the list of Office-Bearers of the Philological Section was agreed to.

8. At the close of the business proper to the Annual Meeting, the Chairman briefly referred to the great zeal and efficiency with which Dr. Russell had discharged the duties of the Presidentship during his term of office, and moved the best thanks of the Society to that gentleman, which he shortly acknowledged.

9. Mr. MAGNUS MACLEAN, M.A., F.R.S.E., and Mr. MAKITA GOTO, both of the Physical Laboratory, University of Glasgow, submitted a paper on "Electrification of Air by Combustion" (being a communication from the Mathematical and Physical Section). The thanks of the Meeting were awarded to the Authors, and a discussion followed in which the speakers were the President, Mr. J. T. Bottomley, Professor Blyth, and Mr. W. Key.

10. It was agreed to postpone the paper, announced in the Billet on behalf of Mr. William Smart, till next meeting.

11. The President announced that the following Candidates for Membership of the Society had all been elected:—Mr. W. C. Martin, electrical engineer, 137 West Regent Street; Mr. William Wilson, teacher, 290 Renfrew Street; Dr. J. L. Kelly, Crosshill; Mr. Henry Brier, M.Inst.M.E., Scotch and Irish Oxygen Company, Polmadie; Mr. James Reid, merchant, 15 Montgomerie Crescent, Kelvinside; Mr. Ebenezer Kemp, Overbridge, Ibrox; Mr. J. B. Atkinson, H.M. Inspector of Mines, 10 Foremount Terrace, Partick; Mr. Robert Anderson, printer, 22 Ann Street; Mr. John T. Costigane, warehouseman, Hampton House, Ibrox; Mr. Alfred Mavor, electrical engineer, 4 Elmbank Crescent; Mr. Sam. Mavor, electrical engineer, 4 Elmbank Crescent; Mr. R. T. R. Anderson, chemist, 618 Gallowgate Street; Mr. D. M. Stevenson, merchant, 12 Waterloo Street.

*4th December, 1889.*

The Second Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 4th December, 1889, at Eight o'clock—Dr. J. G. M'Kendrick, President, in the Chair.

1. The Minutes of the Annual General Meeting of the Society, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. W. C. Martin, Mr. William Wilson, Dr. J. L. Kelly, Mr. Henry Brier, Mr. James Reid, Mr. Ebenezer Kemp, Mr. J. B. Atkinson, Mr. Robert Anderson, Mr. John T. Costigane, Mr. Alfred Mavor, Mr. Sam Mavor, Mr. R. T. R. Anderson, and Mr. D. M. Stevenson were admitted to the Membership of the Society.

3. Mr. William Smart, M.A., read a paper on "How the Problem of Housing the Poor has been solved in London," being a communication from the Economic Science Section. After some remarks from the Chairman on the subject of the paper, a vote of thanks was awarded to Mr. Smart. A discussion then ensued, the speakers being—Bailie Dunlop, Mr. James Chalmers, Bailie Bowman, Mr. John Mann, jun., Mr. John Kinneear, Mr. Alexander Cross, Mr. David Thomson, Mr. William Fife, Councillor Mechan, Mr. W. R. W. Smith, Mr. James Mavor, Mr. Francis Smith, Mr. John Farquhar, and Councillor Burt, some of whom were present by invitation.

4. A communication, named in the Billet, from Mr. Daniel R. Gardner, was held over till next Meeting.

5. The President announced that the following candidates for Membership of the Society had all been elected:—Rev. William Leggat, Buchanan Institution; Mr. Archibald Barr, B.Sc., Professor of Civil Engineering and Mechanics, 7 North Park Terrace, Hillhead; Mr. David J. Knox, bookseller, 129 West George Street; Mr. Andrew Gray, builder, 30 Bath Street; Mr. Peter Hutchison, shipowner, 3 Lilybank Terrace, Hillhead; Mr. Maclean Brodie, C.A., 44 Westbourne Gardens; Dr. Thomas F. Macdonald, Burgh House, Maryhill; Mr. James M'Cracken, banker, 5 Bowmont Terrace, Kelvinside; Mr. William J. Mirrlees, engineer, Redlands, Kelvinside; Mr. William Strang Steel,

merchant, Braco Castle, Braco, Perthshire ; Mr. Charles A. Rose, paper manufacturer, 1 Belhaven Crescent, Kelvinside ; Mr. Donald M'Phee, 4 Kirklee Road, Kelvinside ; Mr. Peter Galbraith, merchant, 17 Huntly Gardens.

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*11th December, 1889.*

A Joint-Meeting of the Philosophical Society and the Royal Scottish Geographical Society was held in the Hall, 207 Bath Street, on Wednesday Evening, 11th December, at Eight o'clock. Dr. J. G. M'Kendrick, President, occupied the Chair, and introduced Dr. Thomas Muir, M.A., F.R.S.E., as President of the Geographical and Ethnological Section, who proceeded to deliver his Inaugural Address on "The Territorial Expansion of the British Empire during the past Ten Years." At the close he was awarded the thanks of the Meeting, on the motion of Mr. Alexander Scott.

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*18th December, 1889.*

The Third Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 18th December, 1889, at Eight o'clock —Mr. J. T. Bottomley, F.R.S., Vice-President, in the Chair.

1. The Minutes of the Second Ordinary Meeting of the Society, and of the Extra Meeting held on the 11th December, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Rev. William Leggat, Buchanan Institution ; Professor Archibald Barr, B.Sc. ; Mr. David J. Knox, Mr. Andrew Gray, Mr. Peter Hutchison, Mr. MacLean Brodie, C.A. ; Dr. Thomas F. Macdonald, Mr. James M'Cracken, Mr. William J. Mirrlees, Mr. William Strang Steel, Mr. Charles A. Rose, Mr. Donald M'Phee, and Mr. Peter Galbraith were admitted to the Membership of the Society.

3. Mr. Daniel Gardner submitted a short communication (postponed from the preceding Meeting) on "The Conversion of Ordinary Gas Globes into Regenerative Lamps : a Simple Method of Applying Highly-heated Air to the Combustion of Illuminating

Gas." The paper was practically illustrated. After some remarks by Mr. Foulis, Gas Engineer, in the course of which he spoke very commendably of the improvements described, Mr. Gardner received the thanks of the Society.

4. Mr. H. Llewellyn Smith, B.A., B.Sc., F.S.S., London, by invitation of the Economic Science Section, read a paper on "The Economic Aspects of the London Dockworkers' Strike," for which he was awarded the thanks of the Society. A discussion took place in which the speakers were the Chairman, Mr. Cree, Mr. Smart, Mr. W. R. W. Smith, Mr. J. H. Kerr (Glasgow School Board), Mr. Kemp, Mr. John Robertson, Mr. James Mavor, and Mr. R. Duncan. A short reply by the Author brought the discussion to a close.

5. The Chairman announced that the following candidates for Membership of the Society had all been elected:—Mr. John Henderson, merchant, Towerville, Helensburgh; Mr. Robert Osborne, merchant, 3 Montgomerie Crescent; Mr. A. P. Barclay, merchant, 63 St. Vincent Street; Mr. Francis H. Newbery, Government School of Art; Mr. George Munro Kerr, shipowner, 97 Buchanan Street.

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*8th January, 1890.*

The Fourth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 8th January, 1890, at Eight o'clock—Dr. J. G. M'Kendrick, F.R.S., President, in the Chair.

1. The Minutes of the Third Ordinary Meeting of the Society, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. John Henderson, Mr. Robert Osborne, Mr. A. P. Barclay, Mr. Francis H. Newbery, and Mr. George Munro Kerr were admitted to the Membership of the Society.

3. A paper was read on "Glimpses into Teutonic Antiquity," by Dr. Georg Fiedler, Lecturer on German Language and Literature, Queen Margaret College and University of Glasgow. (A communication from the Philological Section.) After a few remarks by the President at the close of the paper, a hearty vote of thanks was passed to Dr. Fiedler.

4. Professor James Blyth, M.A., F.R.S.E., submitted a short communication on "Electrical Oscillation," which was experimentally illustrated. A discussion followed, in which the speakers were—the President, Mr. Magnus Maclean, Mr. Henry A. Mavor, and Mr. A. Mechan. Professor Blyth received the thanks of the Society for his paper.

5. The Chairman announced that the following candidates for Membership of the Society had all been elected:—Mr. Charles Stuart-Gorman, 6 Broomhill Avenue, Partick; Mr. Robert Orr, manufacturing chemist, 79 West Nile Street; Councillor Samuel Chisholm, wholesale grocer, 4 Royal Terrace; Mr. John Cassells, Tradeston Paint Mills, Cook Street.

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*22nd January, 1890.*

The Fifth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 22nd January, 1890, at Eight o'clock—Dr. J. G. M'Kendrick, F.R.S., President, in the Chair.

1. The Minutes of the Fourth Ordinary Meeting of the Society, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. Charles Stuart-Gorman, Mr. Robert Orr, Councillor Samuel Chisholm, and Mr. John Cassells were admitted to the Membership of the Society.

3. The President, on behalf of the Librarian, laid on the table a copy of Professor Ernst von Haeckel's recent work, presented by the Author, who is an Honorary Member of the Society.

4. A Lecture on the Forth Bridge, very fully illustrated, was given by Mr. Alfred E. Mavor, M.Inst.E.E., and of the Contractor's Staff at Queensferry. At the conclusion some remarks were made on the subject by the President and Prof. Barr, C.E., and Mr. Mavor was awarded a hearty vote of thanks for his interesting lecture.

5. The Chairman announced that the following candidates for Membership of the Society had all been elected :—Mr. L. Talbot Crosbie, Scotstounhill, Whiteinch ; Mr. D. Scott Ferguson, banker, 10 Belhaven Terrace ; Mr. C. W. Townsend, Chemical Works, Crawford Street, Port-Dundas.

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*5th February, 1890.*

The Sixth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 5th February, 1890, at Eight o'clock—Dr. J. G. M'Kendrick, F.R.S., President, in the Chair.

1. The Minutes of the Fifth Ordinary Meeting of the Society, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. L. Talbot Crosbie, Mr. D. Scott Ferguson, and Mr. C. W. Townsend were admitted to the Membership of the Society.

3. A Communication was read by Mr. Mayer, Secretary, from Dr. Henry Muirhead, Vice-President of the Society, "On the Relationship which the Perihelia of Comets bear to the Sun's flight in Space." Dr. Muirhead was awarded a vote of thanks for his paper.

4. Physical Laboratory Notes were read—(a) by Mr. George E. Allan, "On the alteration of the Index of Refraction of Water with Temperature;" (b) "On the Electro-magnetic effect of a Moving Charge," by Professor James Blyth, M.A., F.R.S.E. The thanks of the Society were awarded to both gentlemen.

5. Dr. William Snodgrass, M.A., submitted a short communication on "Nerve Cells," and gave a microscopical demonstration of the same, for which he received the best thanks of the Society.

6. The Chairman announced that the following candidates for Membership of the Society had been elected :—Mr. M. Officer Davidson, 106 Buchanan Street; Mr. Melville Fraser, 31 St. Vincent Place.

*19th February, 1890.*

The Seventh Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 19th February, 1890, at Eight o'clock—Dr. J. G. M'Kendrick, F.R.S., President, in the Chair.

1. The Minutes of the Sixth Ordinary Meeting of the Society, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. M. O. Davidson and Mr. Melville Fraser were admitted to the Membership of the Society.

3. The President referred to the fact that since the last Meeting of the Society, Mr. Thomas Napier, the Sub-Librarian and Curator, had died, after being in the service of the Society for about eleven years. He spoke of the deceased in feeling terms, and moved that a record of Mr. Napier's death be entered in the Minutes.

4. Rev. James Robertson, D.D., Professor of Oriental Languages in the University of Glasgow, read a paper on "The Trade Guilds of Damascus," for which he received the thanks of the Society, on the motion of Dr. Colville.

5. Dr. T. F. Macdonald read a short paper describing the Hydrostatic Arrangements in the Horse's Foot. On the motion of the President, who made a few remarks on the communication, Dr. Macdonald was awarded the thanks of the Society.

6. The President exhibited and briefly described—(a) A small Noë-Dorfel Thermal Battery; (b) An Improved Induction Coil for Physiological purposes.

7. Mr. W. Arthur Coulson, electrical engineer, showed in operation, and gave a short description of a new Self-contained Electric Lamp for Table Use, worked from a Primary Battery within itself. After answering several questions, Mr. Coulson was awarded the thanks of the Society.

8. The Chairman announced that the following candidate for Membership of the Society had been elected:—Mr. William Aitken, engineer, National Telephone Company.

*5th March, 1890.*

The Eighth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 19th February, 1890, at Eight o'clock—Dr. J. G. M'Kendrick, F.R.S., President, in the Chair.

1. The Minutes of the Seventh Ordinary Meeting of the Society, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. William Aitken was admitted to the Membership of the Society.

3. The President vacated the Chair in favour of Professor Dittmar, F.R.S., President of the Chemical Section, who briefly introduced Professor A. Crum-Brown, F.R.S., University of Edinburgh, who had been appointed to deliver the Fourth Triennial "Graham" Lecture, the subject of which was "The Basicity of Acids." At its close the Lecturer, on the motion of Sir William Thomson, seconded by Mr. Robert R. Tatlock, was awarded the best thanks of the Society, which he cordially acknowledged.

4. The Chairman announced that the following candidate for Membership of the Society had been elected:—Mr. James Donaldson, Gas-works, Cambuslang.

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*19th March, 1890.*

The Ninth Ordinary Meeting of the Society for Session 1889-90 was held on the Evening of Wednesday, 19th March, 1890, at Eight o'clock, in the Banqueting Hall, City Chambers, the use of which for this special occasion had been kindly granted to the Society by the Lord Provost, Magistrates, and Town Council. Dr. J. G. M'Kendrick, F.R.S., President, occupied the Chair.

1. Mr. James Donaldson was admitted to the Membership of the Society.

2. The President stated the special reason for holding the meeting in the Banqueting Hall; and, noticing the large attend-

ance of Members of the Society, Members of the Town Council, and friends who were present by invitation, he said that although it was called in the Billet an Ordinary Meeting of the Society, it was really an Extraordinary Meeting.

3. He then called upon Mr. Henry A. Mavor, Member of the Institution of Electrical Engineers, who proceeded to give a Lecture on "Public Lighting by Electricity," which was very fully illustrated by experiments, by apparatus, and by lantern views. At the close of the Lecture, Sir William Thomson made some interesting remarks on the same subject, and, on his motion, the thanks of the Meeting were enthusiastically awarded to Mr. Mavor for his Lecture.

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*2nd April, 1890.*

The Tenth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 2nd April, 1890, at Eight o'clock—Dr. Charles Gairdner, President of the Economic Science Section, in the Chair.

1. The Minutes of the Eighth and Ninth Ordinary Meetings of the Society, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Owing to illness, Mr. Mark Davidson, M.A., LL.B., Advocate, Edinburgh, was not able to read the paper which he had promised. His place was taken by Mr. Robert Hill, W.S., of the Caledonian Railway Company, who read a paper on "The Incidence of Local Taxation and a Proposed National System," being a communication from the Economic Science Section. A discussion ensued, in which the speakers were Councillor Burt, Mr. Barclay, Mr. Westlands, Mr. Phillips, and the Chairman, on whose motion a vote of thanks was awarded to Mr. Hill, who briefly replied.

3. Mr. T. L. Watson, architect, exhibited and briefly described an Improved Form of Drain Pipe, for which he received the thanks of the Meeting.

*16th April, 1890.*

The Eleventh Ordinary Meeting of the Philosophical Society of Glasgow was held in the Natural Philosophy Class-Room of the University, on the Evening of Wednesday, 16th April, 1890, at Eight o'clock—Dr. J. G. M'Kendrick, F.R.S., President, in the Chair.

1. The Minutes of the Tenth Ordinary Meeting of the Society, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Dr. Oliver J. Lodge, F.R.S., Professor of Physics in University College, Liverpool, delivered a Lecture on "Electrical Oscillation," which was very fully illustrated by experiments. At the close, the Chairman, Sir William Thomson, and Sir Archibald C. Campbell, Bart., M.P., made some remarks on the subject of the Lecture; and a cordial vote of thanks was passed to Professor Lodge, who briefly replied.

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*30th April, 1890.*

The Twelfth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 30th April, 1890, at Eight o'clock—Dr. J. G. M'Kendrick, F.R.S., President, in the Chair.

1. The Minutes of the Eleventh Ordinary Meeting of the Society, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Dr. F. O. Bower, M.A., F.L.S., Professor of Botany in the University of Glasgow, delivered a Lecture on "Club Mosses: Past and Present," which was extensively illustrated by specimens and diagrams. At the close of the lecture he was awarded the best thanks of the Meeting. Some remarks were made on the subject of the lecture by Professor King, Mr. John Young, F.G.S., and Mr. James Thomson, F.G.S.; and Professor Bower briefly replied. Mr. Joseph Sommerville, on behalf of the members of the Geological and Natural History Societies, who were present by invitation, thanked the Council of the Philosophical Society for their kindness in giving them the invitation to be present to hear such

an interesting lecture. The vote of thanks was acknowledged by the President.

3. The Secretary announced the receipt of the Report from the Delegate to the British Association Conference, Newcastle Meeting, 1889; and the Annual Reports of the Sections by the Secretaries of the same. The President stated that these would appear in the next volume of the *Proceedings*.

4. The Chairman announced that two Candidates whom the Council had nominated for vacancies in the list of Honorary Members of the Society, had been unanimously elected: they were Professor G. Quincke, of the University of Heidelberg; and Lord Rayleigh, Secretary of the Royal Society, and Past-President of the British Association.\*

He then adjourned the Society for the Summer recess.

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\* The new Honorary Members have both acknowledged their election into the Society. Professor Quincke's letter is as follows:—

HEIDELBERG, 20th May, 1890.

DEAR SIR,

I have the pleasure to acknowledge your letter of 9th May, and I must ask you to be so good as to express to the Council of the Philosophical Society my deep sense of the honour they have done me. I have to thank you also for the volume of the *Proceedings* of your Society which you have been so good as to forward to me. I am unfortunately not able to visit Glasgow frequently, but perhaps the Philosophical Society may not object to receive occasionally some communication on some physical subject from me through my friends Sir William Thomson or Professor J. T. Bottomley.

I am,

Yours faithfully,

DR. GEORG QUINCKE.

JOHN MAYER, Esq., Secretary of  
the Philosophical Society of Glasgow.

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Royal Institute of British Architects, . . . . .	London.
Royal Institute of Lombardy, . . . . .	Milan.
Royal Institution of Cornwall, . . . . .	Truro.
Royal Institution of Great Britain, . . . . .	London.
Royal Irish Academy, . . . . .	Dublin.
Royal Microscopical Society, . . . . .	London.
Royal Physical Society of Edinburgh, . . . . .	Edinburgh.
Royal Prussian Academy of Science, . . . . .	Berlin.
Royal Scottish Society of Arts, . . . . .	Edinburgh.
Royal Society of Canada, . . . . .	Quebec.
Royal Society of Edinburgh, . . . . .	Edinburgh.
Royal Society of London, . . . . .	London.
Royal Society of New South Wales, . . . . .	Sydney.
Royal Society of Tasmania, . . . . .	Hobart Town.
Royal Society of Victoria, . . . . .	Melbourne.
School of Mines, . . . . .	New York.
Science, . . . . .	Cambridge, Mass.
Science Monthly, . . . . .	London.
Scientific Society of Manitoba, . . . . .	Winnipeg.
Scottish Geographical Society, . . . . .	Edinburgh.
Scottish Meteorological Society, . . . . .	„
Seismological Society of Japan, . . . . .	Tokio.
Smithsonian Institution, . . . . .	Washington.
Social Science Association, . . . . .	London.
Sociedad Científica "Antonio Alzate," . . . . .	Mexico.
Society for Psychical Research, . . . . .	London.
Société des Sciences Physiques et Naturelles, . . . . .	Bordeaux.
Société Royal des Sciences de Liège, . . . . .	Liège.
Society of Arts, . . . . .	London.
Society of Chemical Industry, . . . . .	„
Society of Engineers, . . . . .	,

South Wales Institute of Engineers, . . . . .	Swansea.
Statistical Society, . . . . .	London.
United States Geologist, . . . . .	Washington.
United States Observatory, . . . . .	„
United States Survey, . . . . .	„
University of Christiania, . . . . .	Christiania.
University of Tokio, Japan, . . . . .	Tokio, Japan.
Verein für Erdkunde zu Halle, . . . . .	Halle.
Videnskabs-Selskabet i Christiania, . . . . .	Christiania.
Washburn Observatory—University of Wisconsin, . . . . .	Washburn.
Wagner Free Institute of Science, . . . . .	Philadelphia.
Wissenschaftliche Verein zu Santiago, . . . . .	Santiago, Chile.

## LIST OF PERIODICALS.

## WEEKLY.

Academy.	Engineering.
Architect.	English Mechanic.
Athenæum.	Industries.
British Architect.	Iron.
British Journal of Photography.	Journal of the Society of Arts.
Builder.	Journal of Gas Lighting, &c.
Building News.	Lancet.
Chemical News.	Nature.
Comptes Rendus.	Notes and Queries.
Dingler's Polytechnisches Journal.	Pharmaceutical Journal.
Economist.	Science.
Electrical Review.	Scientific American and Supplement.
Electrician.	
Engineer.	

## FORTNIGHTLY.

Berichte der Deutschen Chemischen Gesellschaft.	Journal für Praktische Chemie.
Bulletin de la Société Chimique de Paris.	Zeitschrift für Angewandte Chemie.

## MONTHLY.

American Journal of Science and Arts.	Analyst.
Annales de Chimie et de Physique.	Antiquary.
Annales des Ponts et des Chaussées.	Beiblätter zu den Annalen der Physik und Chemie.
Annales des Sciences Naturelles—Botanique.	Boletin Mensuel d'Observatorio Meteorologico-Magnetico Central de Mexico.
Annales des Sciences Naturelles—Zoologie.	Bulletin de la Société d'Encouragement.
Annalen der Chemie.	Bulletin de la Société Géologique de France.
Annalen der Physik und Chemie.	
Annals and Magazine of Natural History.	

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|---|---|
| Bulletin Mensuel de l'Observatoire de Montsouris. | Journal of the Scottish Geographical Society.                                   |
| Canadian Entomologist.                            | London, Edinburgh, and Dublin Philosophical Magazine.                           |
| Chamber of Commerce Journal.                      | Midland Naturalist.   |
| Entomologist.                                     | Monatsbericht der Königlich Preussischen Akademie der Wissenschaften zu Berlin. |
| Entomologists' Monthly Magazine.                  | Proceedings of Royal Society of London.   |
| Geological Magazine.                              | Proceedings of Royal Geographical Society.                                      |
| Hardwicke's Science Gossip.                       | Royal Astronomical Society's Monthly Notices.                                   |
| Journal of the Franklin Institute.                | Sanitary Journal.   |
| Journal de Pharmacie et de Chimie.                | Zoologist.  |
| Journal of Botany.                                |   |
| Journal of the Photographic Society.              |   |
| Journal of Science.                               |   |
| Journal of Society of Chemical Industry.          |   |
| Journal of the Chemical Society.                  |   |

## QUARTERLY.

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| Annales des Mines.   | Mind: a Quarterly Review of Psychology and Philosophy. |
| Annals of Botany.  | Quarterly Journal of Economics.                        |
| Archives Néerlandaises des Sciences Exactes et Naturelles. | Quarterly Journal of Geological Society.               |
| Bulletin de la Société Industrielle de Mulhouse.           | Quarterly Journal of Microscopical Science.            |
| Fortschritte der Mathematik.                               | Quarterly Journal of Pure and Applied Mathematics.     |
| Grevillea.   | Revue Universelle des Mines.                           |
| Journal of Anatomy and Physiology.                         | Zeitschrift für Analytische Chemie.                    |
| Journal of the Scottish Meteorological Society.            |  |
| Journal of the Statistical Society.                        |  |

LIST OF MEMBERS  
OF THE  
PHILOSOPHICAL SOCIETY OF GLASGOW,  
FOR 1890-91.

HONORARY MEMBERS.

*(Limited to Twenty.)*

WITH YEAR OF ELECTION.

FOREIGN.

Hermann Ludwig Ferdinand von Helmholtz, Berlin. . . . .	1860
Rudolph Albert von Kölliker, Würzburg. . . . .	1860
Wilhelm Weber, Göttingen. . . . .	1860
Ernst Heinrich Hæckel, Jena. . . . .	1880
5 Louis Pasteur, Paris. . . . .	1885
Georg Quincke, Heidelberg. . . . .	1890

AMERICAN AND COLONIAL.

James Dwight Dana, LL.D., Professor of Geology and Mineralogy in Yale College, Connecticut. . . . .	1860
Robert Lewis John Ellery, F.R.A.S., Victoria. . . . .	1874
Sir John William Dawson, LL.D., F.R.S., Principal of Macgill College, Montreal. . . . .	1883

BRITISH.

10 Sir Andrew Crombie Ramsay, LL.D., F.R.S., London. . . . .	1874
Sir Joseph Dalton Hooker, K.C.B., K.C.S.I., M.D., D.C.L., LL.D., F.R.S., Kew. . . . .	1874
Thomas Henry Huxley, Ph.D., LL.D., D.C.L., F.R.S., London. . . . .	1876
Herbert Spencer, London. . . . .	1879
John Tyndall, LL.D., D.C.L., F.R.S., M.R.I., London. . . . .	1880
15 Rev. John Kerr, LL.D., Glasgow. . . . .	1885
Sir George Gabriel Stokes, Bart., M.A., LL.D., D.C.L., Pres.R.S., M.P., Cambridge. . . . .	1887
F. Max Müller, M.A., Professor of Comparative Philology, Oxford. . . . .	1889
The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., Sec.R.S., London. . . . .	1890

## CORRESPONDING MEMBERS.

WITH YEAR OF ELECTION.

Rev. H. W. Crosskey, LL.D., F.G.S., 117 Gough road, Birmingham. . . . .	1874
A. S. Herschel, M.A., D.C.L., F.R.S., F.R.A.S., Hon. Professor of Experimental Physics in the Durham College of Science, Newcastle-on-Tyne; Observatory House, Slough, Bucks. . . . .	1874
Thomas E. Thorpe, Ph.D., F.R.S., Royal School of Mines, London. . . . .	1874
John Aitken, F.R.S., F.R.S.E., Darroch, Falkirk. . . . .	1883
5 Alex. Buchan, M.A., LL.D., F.R.S.E., Secretary to the Scottish Meteorological Society, 73 Northumberland street, Edinburgh. . . . .	1883
James Dewar, M.A., F.R.S., F.R.S.E., M.R.I., Jacksonian Professor of Physics, University of Cambridge, and Professor of Chemistry in the Royal Institution of Great Britain. . . . .	1883
Stevenson Macadam, Ph.D., F.R.S.E., Lecturer on Chemistry, Surgeons' Hall, Edinburgh. . . . .	1883
Joseph W. Swan, M.A., Newcastle-on-Tyne and London. . . . .	1883
E. A. Wunsch, F.G.S., London. . . . .	1883
10 George Anderson, Master of the Mint, Melbourne. . . . .	1885

## ORDINARY MEMBERS.

WITH YEAR OF ENTRY.

\* Denotes Life Members.

Ackroyd, J. E., 7 Campbell street, Maryhill. . . . .	1887	Annandale, Charles, M.A., LL.D., 86 Dixon avenue, Crosshill. . . . .	1888
Adam, William, M.A., 415 Sauchie-hall street. . . . .	1876	Arnot, James Craig, 162 St. Vincent street. . . . .	1869
Addie, John, 144 St. Vincent street. . . . .	1861	Arrol, Walter, 16 Dixon street. . . . .	1869
Aikman, C. M., M.A., B.Sc., F.R.S.E., F.I.C., F.C.S., Lecturer on Agricultural Chemistry, Technical College, 183 St. Vincent street. . . . .	1886	Arrol, William A., 16 Dixon street. . . . .	1869
5 Aitken, William, National Telephone Co. . . . .	1890	25 Atkinson, J. B., 10 Foremount terrace, Partick. . . . .	1889
Alexander, D. M., 8 Royal Crescent, Crosshill. . . . .	1887	Bain, Sir James, F.R.S.E., 3 Park terrace. . . . .	1866
Alexander, Peter, M.A., 26 Smith street, Hillhead. . . . .	1885	Bain, Robert, 132 West Nile street. . . . .	1869
Alexander, Thos., 48 Sardinia ter. . . . .	1869	Balloch, Robert, 131 St. Vincent street. . . . .	1843
Alexander, William, Helen street, Govan. . . . .	1889	Balmain, Thos., 1 Kew terrace, Kelvinside. . . . .	1881
10 Alley, Stephen, Sentinel Works, Polmadie road. . . . .	1884	30 Barclay, A. P., 63 St. Vincent street. . . . .	1889
Alston, J. Carfrae, 9 Lorraine Gardens, Dowanhill. . . . .	1887	Barclay, James, 36 Windsor terrace. . . . .	1871
Amours, F. J., B.A., High School. . . . .	1888	Barlow, John, M.D., Professor of Physiology, St. Mungo's College, 8 Elmbank crescent. . . . .	1880
Anderson, Alexander, 157 Trongate. . . . .	1869	Barrett, Francis Thornton, Mitchell Library. . . . .	1880
Anderson, John, 22 Ann street. . . . .	1884	Barr, Archibald, D.Sc., Professor of Civil Engineering and Mechanics, University of Glasgow. . . . .	1889
15 Anderson, Robert, 22 Ann street. . . . .	1889	35* Barr, James, C.E., I.M., 132 West Regent street. . . . .	1883
Anderson, Robert, jun., 22 Annstreet. . . . .	1887	Barr, Thos., M.D., F.F.P.S.G., 7 Albany place. . . . .	1879
Anderson, R. T. K., 617 Gallowgate street. . . . .	1889	Bathgate, William, M.A., 13 Westbourne gardens. . . . .	1887
*Anderson, T. M'Call, M.D., Professor of Clinical Medicine in the University of Glasgow, 2 Woodside terrace. . . . .	1873	Bayne, A. Malloch, 1 Hamilton terrace, Partick. . . . .	1878
Anderson, W. F. G., 47 Union street. . . . .	1878	Beatson, George T., B.A. Cantab., M.D., 2 Royal crescent. . . . .	1881
20 Annan, J. Craig, 153 Sauchiehall st. . . . .	1888		

- 40 Begg, Wm., 636 Springfield road. 1883  
 \*Beith, Gilbert, 7 Royal Bank place. 1881  
 Bell, Dugald, 27 Lansdowne cres. 1871  
 \*Bell, Henry, 5 Cornwall terrace,  
 Regent's Park, London, N.W. 1876  
 Bell, James, 7 Marlborough terrace,  
 Kelvinside. 1877  
 45 Bennett, Robert J., 8 Holland place. 1883  
 Bilsland, William, 3 Lynedoch place. 1888  
 Binnie, J., 69 Bath street. 1877  
 Binnie, Robert, Ashbourne, Gourrock. 1881  
 Black, Adam Elliot, C.A., F.C.S.,  
 5 Hillsborough square, Bruce st.,  
 Hillhead. 1880  
 50 Black, D. Campbell, M.D., M.R.C.S.E.,  
 121 Douglas street. 1872  
 Black, J. Albert, Duneira, Row. 1869  
 Black, John, 16 Park terrace. 1869  
 Black, Malcolm, M.B., C.M., 5 Can-  
 ning place. 1880  
 \*Blackie, J. Alexander, 17 Stanhope 1881  
 street.  
 55 \*Blackie, J. Robertson, 17 Stanhope 1881  
 street.  
 Blackie, Robert, 17 Stanhope st. 1847  
 Blackie, W. G., Ph.D., LL.D.,  
 F.R.G.S., 17 Stanhope street. 1841  
 Blackie, Walter W., B.Sc., 17 Stan-  
 hope street. 1886  
 Blair, G. M'Lellan, 2 Lilybank  
 terrace. 1869  
 60 Blair, J. M'Lellan, 2 Bute Gardens,  
 Hillhead. 1869  
 Blair, Matthew, 11 Hampton Court  
 terrace. 1887  
 Blyth, James, M.A., F.R.S.E., Pro-  
 fessor of Mathematics and Natural  
 Philosophy, Anderson's College,  
 204 George street. 1881  
 \*Blyth, Robert, C.A., 1 Montgomerie  
 quadrant. 1885  
 Bost, Wm. David Ashton, Lang-  
 roods, Paisley. 1884  
 65 Bost, Timothy, 33 Renfield street. 1876  
 Bottomley, James T., M.A., F.R.S.,  
 F.R.S.E., F.C.S., Demonstrator  
 in Natural Philosophy, Uni-  
 versity of Glasgow, 13 University  
 gardens, Hillhead. 1880  
 Bottomley, Wm., C.E., 15 University  
 gardens. 1880  
 Boucher, J., I.A., 247 St. Vincent  
 street. 1870  
 Bower, F. O., D.Sc., M.A., F.L.S.,  
 Regius Professor of Botany in  
 the University of Glasgow, 45  
 Kersland terrace. 1885  
 70 Bowie, Campbell T., 26 Bothwell st. 1870  
 Boyd, John, Shettleston Iron-works,  
 near Glasgow. 1873  
 Boyd, Rev. William, LL.D., 6  
 Park street, East. 1885  
 Brand, James, C.E., 172 Buchanan st. 1880  
 Brier, Henry, M. Inst. M. Eng., Scotch  
 and Irish Oxygen Co., Polmadie. 1889  
 75 Brodie, John Ewan, M.D., C.M.,  
 F.F.P.S.G., 1 Albany place. 1873  
 Brodie, Maclean, C.A., 44 West-  
 bourne gardens. 1889  
 Brown, Alexander, 190 Bath street. 1887  
 Brown, G. F. H., 3 South Apsley  
 place. 1889  
 \*Brown, Hugh, 5 St. John's terrace,  
 Hillhead. 1887  
 80 Brown, James, 76 St. Vincent st. 1876  
 \*Brown, John, 11 Somerset place. 1881  
 Brown, John C., 149 West George  
 street. 1880  
 Brown, H. Mathieson, 1 St. James  
 place, Hillhead. 1888  
 Brown, Richard, Strone Colliery Co.,  
 49 W. George street. 1855  
 85 Brown, Robert, 19 Jamaica street. 1882  
 \*Brown, Wm. Stevenson, 41 Oswald  
 street. 1886  
 Brownlee, J., 23 Burnbank gardens. 1860  
 Brownlie, Archibald, Bank of Scot-  
 land, Barrhead. 1880  
 Brownlie, Jas., 104 Hill street,  
 Garnethill. 1877  
 90 Brunton, Rev. Alex., Ardbeg villa,  
 Craigpark, Dennistoun. 1884  
 \*Bryce, Charles C., 141 West George  
 street. 1884  
 Bryce, David, 129 Buchanan street. 1872  
 \*Bryce, Robert, 82 Oswald street. 1886  
 \*Buchan, Wm. P., S.E., 21 Renfrew  
 street. 1875  
 95 Buchanan, Alex. M., A.M., M.D.,  
 Professor of Anatomy, Anderson's  
 College Medical School, 98 St.  
 George's road. 1876  
 Buchanan, George S., 85 Candleriggs. 1845  
 \*Buchanan, William, 10 Carrington  
 street. 1886  
 Burnet, John, I.A., 167 St. Vincent  
 street. 1850  
 Burnet, Lindsay, Assoc. M.I.C.E.,  
 St. Kilda, Dowanhill. 1882  
 100 Burns, J., M.D., 15 Fitzroy place,  
 Sauchiehall street. 1864  
 Burns, J. Cleland, 1 Park gardens. 1874  
 Callajon, Ventura De, 3 Carlton  
 terrace, Kelvinside. 1886  
 Cameron, Charles, M.D., LL.D.,  
 M.P., 104 Union street. 1870  
 Cameron, H. C., M.D., 200 Bath  
 street. 1873  
 105 Cameron, R., Wellpark, Bathgate. 1873  
 \*Campbell, Sir A. C., Bart., M.P., of  
 Blythwood, Renfrew. 1885  
 \*Campbell, J. A., LL.D., M.P.,  
 Strathcathro, Brechin. 1848

- \*Campbell, James, 137 Ingram st. 1885  
 Campbell, John D., 4 Woodvale place, Copeland road, Govan. 1858  
 110 Campbell, John MacNaught, Kelvin-grove Museum. 1883  
 \*Campbell, Louis, 3 Eton terrace, Hillhead. 1881  
 Carlile, Thomas, 23 West Nile street. 1851  
 Carmichael, Neil, M.D., C.M., F.F.P.S.G., Invercarmel, 23 Nithsdale drive, Pollokshields. 1873  
 Cassells, John, 62 Glencairn drive, Pollokshields. 1890  
 115 Cassels, Robert, 168 St. Vincent street. 1858  
 \*Cayzer, Charles W., 109 Hope st. 1886  
 Chalmers, James, I.A., 101 St. Vincent street. 1884  
 Cherrie, James M., Clutha cottage, Tolleross. 1876  
 \*Chisholm, Samuel, 4 Royal ter., W. 1890  
 120 Christie, James, A.M., M.D., F.F.P.S.G., 2 Great Kelvin terrace, Bank street, Hillhead. 1876  
 Christie, John, Turkey-red Works, Alexandria, Dumbartonshire. 1868  
 Chrystal, W. J., F.I.C., F.C.S., Shawfield Works, Rutherglen. 1882  
 Church, W. R. M., C.A., 75 St. George's place. 1885  
 Clapperton, Charles, 16 Lilybank gardens, Hillhead. 1882  
 125 Clapperton, John, 9 Crown Circus drive. 1874  
 \*Clark, G. W., Dumbreck house. 1877  
 Clark, Henry E., F.F.P.S., M.R.C.S. Eng., 24 India street. 1876  
 Clark, John, Ph.D., F.I.C., F.C.S., 138 Bath street. 1870  
 Clark, John, 9 Wilton crescent. 1872  
 130 \*Clark, William, 125 Buchanan st. 1876  
 Clavering, Thos., 27 St. Vincent place. 1856  
 \*Cleland, John, M.D., LL.D., D.Sc., F.R.S., Professor of Anatomy in the University of Glasgow. 1884  
 Clinkskill, James, 1 Holland place. 1868  
 \*Coats, Joseph, M.D., 31 Lynedoch street. 1873  
 135 \*Cochran, Robert, 7 Crown circus, Dowanhill. 1877  
 Coghill, Wm. C., 263 Argyle street. 1873  
 Collins, Sir William, F.R.G.S., 3 Park terrace, East. 1869  
 Colquhoun, Jas., 158 St. Vincent st. 1876  
 Colville, James, M.A., D.Sc., 15 Newton place. 1885  
 140 Combe, William, 257 W. Campbell street. 1877  
 Connal, Sir Michael, Virginia build-ings. 1848  
 Connell, Wm., 38 St. Enoch square. 1870  
 Cooke, Stephen, F.C.S., 85 Buccleuch street. 1886  
 Copeland, Jas., Dundonald road, Kelvinside. 1869  
 145 Copland, Wm. R., M. Inst. C.E., 146 West Regent street. 1876  
 Coste, Jules, French Consulate, 131 West Regent street. 1888  
 Costigane, John T., Hampton house, Ibrox. 1889  
 Coubrough, A. Sykes, Blane field, Strathblane. 1869  
 Coulson, Arthur, 56 George square. 1888  
 150 Couper, James, Craigforth house, Stirling. 1862  
 Cowan, M'Taggart, C.E., 27 Ashton terrace, Hillhead. 1876  
 Craig, Alexander T., 264 St. Vincent street. 1884  
 Craig, T. A., C.A., 139 St. Vincent street. 1886  
 Crawford, David, Ferryfield Print-works, Alexandria, N.B. 1873  
 155 Crawford, Robert, 84 Miller st. 1886  
 Crawford, W. B., 104 W. Regent street. 1872  
 Crawford, Wm. C., M.A., Lock-hartton gardens, Slateford, Edin-burgh. 1869  
 Cree, Thomas S., 21 Exchange sq. 1869  
 Crosbie, L. Talbot, Scotstounhill, Whiteinch. 1890  
 160 Cross, Alexander, 14 Woodlands terrace. 1887  
 Cruikshank, George M., 62 St. Vincent street. 1885  
 Cumming, Thos., Angus Lodge, Hamilton. 1888  
 Cunningham, John M., 18 Woodside terrace. 1881  
 Cunningham, J. R., jun., 30 George square. 1881  
 165 Curphey, Wm. Salvador, 2 Princes square, Strathbungo. 1883  
 Cuthbert, Alexander A., 14 Newton terrace. 1885  
 \*Cuthbertson, Sir John N., 29 Bath street. 1850  
 Dansken, A. B., 179 West George street. 1877  
 \*Dansken, John, I.M., 121 West Regent street. 1876  
 170 Darling, Geo. E., 178 St. Vincent street. 1870  
 Davidson, M. Officer, 106 Buchanan street. 1890  
 Deas, Jas., C.E., 7 Crown gardens, Dowanhill. 1869  
 Dempster, John, 4 Belmar terrace, Pollokshields. 1875

- Dennison, William, C.E., 175 Hope street. 1876
- 175 Dewar, Duncan, St. Fillans, West Coates, Cambuslang. 1877
- \*Dick, George Handasyde, 136 Buchanan street. 1887
- Dittmar, W., LL.D., F.R.S., F.R.S.E., Professor of Chemistry, Anderson's College, 204 George street. 1875
- \*Dixon, A. Dow, 10 Montgomerie crescent, Kelvinside. 1873
- Dobbie, A. B., M.A., University. 1885
- 180 Donald, John, Dennistoun Public School. 1872
- Donald, William J. A., 27 St. Vincent place. 1877
- Donaldson, James, Gas Works, Cambuslang. 1890
- Dougall, Franc Gibb, 167 Canning street. 1875
- Dougall, John, M.D., C.M., F.F.P.S.G., Professor of Materia Medica, St. Mungo's College, 6 Belmar terrace, Pollokshields. 1876
- 185 Douglas, Campbell, I.A., F.R.I.B.A., 266 St. Vincent street. 1870
- Downie, Robert, jun., Carntyne Dye-works, Parkhead. 1872
- Downie, Thomas, Hyde Park Foundry. 1886
- Drew, Alex., 175 West George street. 1869
- Duncan, Eben., M.D., C.M., F.F.P.S.G., 4 Royal crescent, Crosshill. 1873
- 190\*Duncan, Walter, 9 Montgomerie crescent. 1881
- Dunlop, E. D., 40 W. Nile street. 1883
- \*Dunlop, Nathaniel, 1 Montgomerie crescent, Great Western road. 1870
- Dunn, Robert Hunter, 4 Belmont crescent. 1878
- \*Dyer, Henry, M.A., D.Sc., C.E., 8 Highburgh terrace, Dowanhill. 1883
- 195 Eadie, Alexander, 280 Cathcart road. 1885
- Easton, Walter, 125 Buchanan street. 1878
- Easton, William J., 150 West Regent street. 1876
- \*Edwards, John, Govanhaugh Dye-works. 1883
- Edwards, Matthew, 209 Sauchiehall street. 1887
- 200 Elder, James, C.E., 204 St. Vincent street. 1881
- Elgar, Francis, LL.D., Admiralty, London. 1884
- \*Ellis, T. Leonard, North British Iron-works, Coatbridge. 1888
- Erskine, Jas., M.A., M.B., L.F.P.S., 5 Charing Cross mansions. 1886
- \*Ewing, Wm., 7 Royal Bank place. 1883
- 205 Fairweather, Wallace, C.E., 62 St. Vincent street. 1880
- Falconer, Patrick, 33 Hayburn crescent, Partick. 1876
- Falconer, Thos., 50 Kelvingrove st. 1880
- Farguhar, John, 13 Belhaven ter. 1872
- Fawsitt, Charles A., 4 Maule terrace, Partick. 1879
- 210 Fergus, Freeland, M.B., F.F.P.S.G., 3 Elmbank crescent. 1887
- Fergus, Jas., 5 Burnbank gardens. 1880
- Ferguson, D. Scott, 10 Belhaven terrace. 1890
- \*Ferguson, John, M.A., LL.D., Professor of Chemistry, University of Glasgow. 1869
- Ferguson, Peter, 15 Bute gardens, Hillhead. 1866
- 215 Ferguson, Thomas, Westmuir st., Parkhead. 1883
- Fergusson, Alex. A., 48 M'Alpine street. 1847
- Fife, William, 52 Glassford street. 1880
- Finlay, H. G., 16 Westbourne terrace. 1888
- Finlay, Joseph, Clairmont, Winton drive, Kelvinside. 1873
- 220\*Finlay, Robert Gilchrist, jun., Holmfield, Dalmuir. 1881
- Finlayson, James, M.D., 2 Woodside place. 1873
- Fleming, James, 136 Glebe street. 1880
- \*Fleming, William James, M.D., 155 Bath street. 1876
- Fotheringham, T. B., 65 West Regent street. 1889
- 225 Foulis, William, C.E., 45 John st. 1870
- \*Fowler, John, 4 Gray street, Sandyford. 1880
- Frame, James, Union Bank of Scotland, 113 King street, Tradeston. 1885
- Fraser, A. Y., M.A., F.R.S.E., Allan Glen's School. 1889
- Fraser, Matthew P., 91 W. Regent street. 1887
- 230 Fraser, Melville, 31 St. Vincent pl. 1890
- Fraser, Robert, 2 Crown gardens, Dowanhill. 1885
- Frazer, Daniel, 127 Buchanan st. 1853
- Frew, Alex., C.E., 175 Hope street. 1876
- Fullarton, J. H., M.A., B.Sc., Fishery Board Office, Edinburgh. 1886
- 235 Fyfe, Peter, 1 Montrose street. 1886
- Gairdner, Charles, LL.D., Broom, Newton-Mearns. 1884
- \*Gairdner, C. D., C.A., 115 St. Vincent street. 1886

- Gairdner, W. T., M.D., LL.D., Professor of Practice of Medicine in the University of Glasgow, 225 St. Vincent street. 1863
- Galbraith, Peter, 17 Huntly gardens. 1889
- 240 Gale, Jas. M., C.E., 45 John street. 1856
- Galloway, T. Lindsay, C.E., 43 Mair street, Plantation. 1881
- Galt, Alex., B.Sc., F.R.S.E., F.C.S., Gowanbrae, Dunoon. 1887
- Gardner, Daniel, 36 Jamaica street. 1869
- \*Garroway, John, 694 Duke st 1875
- 245 Geddes, Wm., 8 Battlefield crescent, Langside. 1846
- Gillies, W. D., 2 Royal Exchange court. 1872
- Gilfillan, Wm., 129 St. Vincent st. 1881
- Glaister, John, M.D., F.F.P.S.G., D.P.H., Camb., &c., Professor of Medical Jurisprudence and Public Health, St. Mungo's College, 4 Grafton Place. 1879
- Goldie, James, 40 St. Enoch square. 1883
- 250 Goodwin, Robert, 58 Renfield street. 1875
- Gorman, C. S., 6 Broomhill avenue, Partick. 1889
- Gourlay, John, C.A., 24 George square. 1874
- Gourlay, Robert, Kirklee avenue, Great Western road. 1869
- Gow, Leonard, 19 Waterloo street. 1889
- 255 Gow, Leonard, jun., 19 Waterloo street. 1884
- Gow, Robert, Cairndowan, Downhill gardens. 1860
- Graham, Alex. M., 20 Dixon street. 1887
- Graham, David, jun., 140 Douglas street. 1876
- Graham, Robert, 61 Eglinton street. 1888
- 260\*Graham, William, 195 Bath street. 1885
- Grant, Robt., M.A., LL.D., F.R.S., Professor of Astronomy in the University of Glasgow, Observatory, *Hon. Vice-President.* 1860
- Gray, Andrew, 30 Bath street. 1889
- Gray, James, M.D., 15 Newton terrace. 1863
- Gray, James, 2 Balmoral crescent, Crosshill. 1876
- 265 Gray, Thomas, B.Sc., F.R.S.E., Physical Laboratory, University. 1887
- Greenlees, Alex., M.D., 33 Elmbank street. 1864
- Grierson, James, 5 Belhaven cres., Kelvinside. 1880
- Grieve, John, M.A., M.D., F.R.S.E., care of W. L. Buchanan, 212 St. Vincent st. 1856
- Griffiths, Azariah, Elmbank, Falkirk. 1886
- 270 Haldane, T. Fred., Cartvale Chemical Works, Paisley. 1884
- Halket, George, M.D., F.F.P.S.G., 4 Royal cres., W. 1889
- Hamilton, John, I.A., 212 St. Vincent street. 1885
- Hannay, Jas. B., F.R.S.E., F.C.S., New Club, West George street. 1879
- Hart, Arthur, 20 Woodlands terrace. 1883
- 275\*Harvie, John, Secretary, Clydesdale Bank, 30 St. Vincent place. 1880
- Harvie, William, 8 Bothwell terrace, Hillhead. 1888
- \*Henderson, A. P., 10 Crown terrace, Dowanhill. 1880
- Henderson, George G., D.Sc., M.A., F.I.C., F.C.S., Chemical Laboratory, University. 1883
- \*Henderson, John, jun., Meadowside Works, Partick. 1879
- 280 Henderson, John, Towerville, Helensburgh. 1890
- Henderson, Robert, 27 Union st. 1885
- Henderson, Thos., 47 Union street. 1855
- Henderson, Wm., Ennerdale, Winton drive, Kelvinside. 1853
- \*Henderson, Wm., 4 Windsor terrace, West. 1873
- 285 Henry, R. W., 10 Garthland street. 1875
- Heys, Zechariah J., South Arthurlie, Barrhead. 1870
- Higginbotham, James S., Springfield court, Queen street. 1874
- Higginbotham, Robert Ker, 10 Great Hamilton street. 1885
- Higgins, Henry, jun., 247 St. Vincent street. 1878
- 290 Hodge, William, 27 Montgomery drive, Kelvinside. 1878
- Hoey, David G., 8 Gordon street. 1869
- Hogg, Robert, Inglisby villa, Nithsdale drive, Pollokshields. 1865
- Holt, T. G., 25 Wellington street. 1875
- Honeyman, John, F.R.I.B.A., 140 Bath street. 1870
- 295 Horne, R. R., C.E., 150 Hope st. 1876
- Horton, William, Birchfield, Mount Florida. 1889
- Howat, William, 37 Elliot street. 1885
- Howatt, James, I.M., 146 Buchanan street. 1870
- Howatt, William, I. M., 146 Buchanan street. 1870
- 300 Hunt, Edmund, 87 St. Vincent st. 1856
- \*Hunt, John, Milton of Campsie. 1881
- \*Hunter, Wm. S., 30 Hope street. 1889
- Hutchison, Peter, 3 Lilybank terrace, Hillhead. 1889
- \*Jack, William, M.A., LL.D., Professor of Mathematics in the University of Glasgow. 1881

- 305 Jackson, William V., 25 Stanley street, W. 1888
- Jamieson, Andrew, F.R.S.E., M.Inst.C.E., M.S.T.E., &c., 38 Bath street. 1881
- Jebb, Richard C., M.A., LL.D., Professor of Greek, Cambridge. 1888
- Johnson, James Yate, C.E., 115 St. Vincent street. 1883
- Johnstone, Jas., Coatbridge street, Port-Dundas. 1869
- 310 Kay, Wm. E., Printworks, Gowan bank, Clarkston, Busby. 1887
- Kean, James, 32 Scotia street, Garnethill. 1888
- Kelly, James K., M.D., F.F.P.S.G., Park villa, Queen Mary avenue, Crosshill. 1889
- Kemp, Ebenezer, Overbridge, Ibrox. 1889
- Kennedy, Hugh, Redclyffe, Partick. 1876
- 315 Kennedy, James, 33 Greendyke st. 1889
- Kennedy, John A., M.B., C.M., Ellangowan, Bearsden. 1888
- Ker, Charles, M.A., C.A., 115 St. Vincent street. 1885
- \*Ker, Wm., 1 Windsor ter., west. 1874
- Kerr, Adam, 175 Trongate. 1887
- 320 Kerr, Charles James, 40 West Nile street. 1877
- Kerr, Geo. Munro, 97 Buchanan street. 1890
- Kerr, James Hy., 13 Virginia st. 1872
- Kerr, John G., M.A., 16 Grafton street. 1878
- Key, William, Tradeston Gas-works. 1877
- 325 King, James, 57 Hamilton drive, Hillhead. 1848
- King, Sir James, Bart., LL.D., of Campsie, 115 Wellington street. 1855
- Kirk, Alexander C., LL.D., 19 Athole gardens, Dowanhill. 1869
- Kirk, Robert, M.D., Newton cottage, Partick. 1877
- Kirkpatrick, Alexander B., 24 Berkeley terrace. 1885
- 330 Kirkpatrick, Andrew J., 179 West George street. 1869
- Knox, Adam, 47 Crownpoint road. 1881
- \*Knox, David J., 129 West George street. 1889
- Knox, John, 151 Renfrew street. 1883
- Laird, George H., 159 Greenhead street. 1882
- 335 Laird, John, Marchmont, Port-Glasgow. 1876
- Laird, John, Royal Exchange Sale Rooms. 1879
- Lamb, Thomas, 220 Parliamentary road. 1870
- Lang, William, jun., F.C.S., Cross-park, Partick. 1865
- Latta, James, 73 Mitchell street. 1869
- 340 Latta, John, 138 West George st. 1880
- Lazenby, Rev. Albert, 50 Prince's square, Strathbungo. 1885
- Leggat, William, Buchanan Institution. 1889
- Leitch, Alexander, 60 Rosebank terrace, Grant street. 1886
- Lester, William, 2 Doune terrace, N. Woodside. 1884
- 345 Lester, W. R., M.A., 2 Doune terrace, N. Woodside. 1884
- \*Lindsay, Archd. M., M.A., 87 West Regent street. 1872
- Lindsay, Wm. G., 156 St. Vincent street. 1871
- Lochore, John, 8 Bellahouston ter., Ibrox. 1886
- \*Long, John Jex, 11 Doune terrace, Kelvinside. 1862
- 350 Lothian, J. Alexander, M.D., L.R.C.S.E., 6 Newton terrace. 1872
- Love, James Kerr, M.D., C.M., 4 Matilda place, Strathbungo. 1888
- Low, James, 176 St. Vincent street. 1878
- M'Andrew, John, 17 Park Circus place. 1843
- M'Ara, Alex., 65 Morrison street. 1888
- 355 Macarthur, J. G., Rosemary Villa, Bowling. 1874
- Macarthur, John L., 13 West Scotland street. 1889
- M'Call, Samuel, 16 Hillsborough square, Hillhead. 1882
- \*M'Clelland, Andrew Simpson, C.A., 4 Crown gardens, Dowanhill. 1884
- M'Convile, John, M.D., 27 Newton place. 1870
- 360 M'Cracken, James, 5 Bowmont terrace, Kelvinside. 1889
- M'Crae, John, 7 Kirklee gardens, Maryhill. 1876
- M'Creath, James, M.E., 208 St. Vincent street. 1874
- Macdonald, Arch. G., 8 Park circus. 1869
- Macdonald, Thomas, 109 Bath street. 1869
- 365 Macdonald, Thomas F., M.B., C.M., Burgh house, Maryhill. 1889
- M'Farlane, Graham Jas., Elderslie. 1882
- Macfarlane, Walter, 12 Lynedoch crescent. 1885
- M'Farlane, Wm., Edina Lodge, Rutherglen. 1888
- M'Gillivray, James P., 207 West Campbell street. 1883
- 370 \*M'Gilvray, R. A., 129 West Regent street. 1880

- M'Gregor, Duncan, F.R.G.S., 37 Clyde place. 1867  
 M'Gregor, James, 1 East India avenue, London, E.C. 1872  
 M'Grigor, Alexander B., LL.D., 172 St. Vincent street. 1857  
 M'Houl, David, Ph.D., Dalquhorn works, Renton. 1883  
 375\* M'Ilwraith, James, 4 Westbourne terrace, Kelvinside. 1872  
 M'Intyre, Wm., Marion Bank, Rutherglen. 1888  
 M'Ivor, R. W. Emerson, F.I.C., F.C.S., St. George's Club, Hanover square, London. 1886  
 Mackay, John Yule, M.D., 34 Elmbank crescent. 1885  
 Mackay, John, jun., 354 Sauchiehall street. 1869  
 380\* M'Kenzie, W. D., 43 Howard st. 1875  
 \*M'Kenzie, W. J., 197 Dumbarton road. 1879  
 \*M'Kendrick, John G., M.D., C.M., LL.D., F.R.S., F.R.S.E., F.R.C.P.E., Professor of Institutes of Medicine in the University of Glasgow, 45 Westbourne gardens, *President*. 1877  
 Mackinlay, David, 6 Great Western terrace, Hillhead. 1855  
 \*Mackinlay, James Murray, 4 Westbourne gardens. 1886  
 385 Mackinlay, Wm., 4 Bothwell terrace, Hillhead. 1887  
 M'Kissack, John, 103 W. Regent st. 1881  
 MacLae, A. Crum, 147 St. Vincent street. 1884  
 MacLean, Walter, 2 Bothwell cir. 1887  
 \*MacLay, David T., 169 W. George street. 1879  
 390 Maclean, A. H., 8 Hughenden terrace, Kelvinside. 1870  
 Maclean, Magnus, M.A., F.R.S.E., 21 Hayburn crescent, Partickhill. 1885  
 MacLehose, James J., M.A., 61 St. Vincent street. 1882  
 M'Lennan, James, 40 St. Andrew's street. 1888  
 Macouat, R. B., 37 Elliot street 1885  
 395 Macphail, Donald, M.D., Garturk cottage, Whiffet, Coatbridge. 1877  
 M'Phee, Donald, 4 Kirklee road, Kelvinside. 1889  
 M'Pherson, George L., 26 Albert road, Crosshill. 1872  
 M'Vail, D. C., M.B., 3 St. James' terrace, Hillhead. 1873  
 M'Whirter, William, Faraday Electrical Works, Govan. 1889  
 400 Machell, Thomas, 39 Great Western road. 1886  
 Main, Robert B., Milverton, Dalziel drive, Pollokshields. 1885  
 Mann, John, C.A., 188 St. Vincent street, *Treasurer*. 1856  
 Mann, John, jun., M.A., C.A., 188 St. Vincent street. 1885  
 Manwell, James, The Hut, 4 Albert drive, Pollokshields. 1876  
 405 Martin, W. C., 137 West Regent st. 1889  
 Marwick, Sir J. D., LL.D., F.R.S.E., Killermont House, Maryhill. 1878  
 Marks, Samuel, Jeanette villa, Tollcross. 1884  
 Mathieson, Thomas A., 3 Grosvenor terrace. 1869  
 Mavor, Alfred E., 4 Elmbank cres. 1889  
 410 Mavor, Henry A., 56 George square. 1887  
 Mavor, James, 93 Hope street. 1885  
 Mavor, Samuel, 4 Elmbank cres. 1889  
 Mayer, John, 11 Balmoral crescent, Crosshill, *Secretary*. 1860  
 Mechan, Arthur, 60 Elliot street. 1876  
 415 Mechan, Henry, 60 Elliot street. 1879  
 Mees, A. R., 136 W. Regent street. 1888  
 Menzies, Thos., Hutchesons' Grammar School, Crown street. 1859  
 \*Menzies, Thos. J., M.A., B.Sc., F.C.S., Stranraer Academy, Stranraer. 1887  
 Michaelson, M., 21 Huntly gardens. 1878  
 420 Middleton, Robert T., 179 West George street. 1860  
 Millar, James, 158 Parliamentary road. 1870  
 Miller, A. Lindsay, 121 W. Regent street. 1878  
 \*Miller, Arch. Russell, The Cairns, Cambuslang. 1884  
 Miller, David S., 8 Royal crescent, W. 1887  
 425\* Miller, George, Winton drive, Kelvinside. 1881  
 Miller, G. J., Frankfield, Shettleston. 1888  
 Miller, John (Messrs. James Black & Co.), 23 Royal Exchange square. 1874  
 Miller, Richard, 54 St. Enoch sq. 1885  
 \*Miller, Thos. P., Cambuslang Dyeworks. 1864  
 430 Miller, W. M., 7 Mansfield place, West Regent street. 1867  
 Mills, Edmund J., D.Sc., F.R.S., "Young" Professor of Technical Chemistry, 60 John street. 1875  
 Milne, William, M.A., B.Sc., F.R.S.E., High School. 1881  
 Mirrlees, James B., Redlands, Kelvinside. 1866  
 \*Mirrlees, William J., Redlands, Kelvinside. 1889

- 435 Mitchell, George A., 67 West Nile street. 1883  
 Mitchell, Jas. L., 10 Gt. Western terrace. 1878  
 Mitchell, Robert, 12 Wilson street, Hillhead. 1870  
 \*Moffatt, Alexander, 47 Union st. 1874  
 Moir, Charles S., 92 Union street. 1884  
 440 Mollison, James, 23 Hayburn cres., Partick. 1889  
 \*Monteith, Robert, Greenbank, Dowanhill gardens. 1885  
 Moore, Alexander, C.A., 209 West George street. 1869  
 Moore, Alexander George, M.A., B.Sc., 13 Clairmont gardens. 1886  
 Morgan, John, Springfield house, Bishopbriggs. 1844  
 445 Morrice, Jas. A., 1 Athole gardens place. 1883  
 Mossman, John, 6 Queen's terrace, West. 1870  
 Motion, James Russell, 38 Cochran street. 1887  
 Muir, Alex., 400 Eglinton street. 1883  
 \*Muir, Allan, 36 George street. 1881  
 450 Muir, James, C.A., 149 West George street. 1887  
 Muir, John, 6 Park gardens. 1876  
 Muir, Thomas, M.A., LL.D., F.R.S.E., Beechcroft, Bothwell. 1874  
 \*Muirhead, Andrew Erskine, Cart Forge, Crossmyloof. 1873  
 Muirhead, James, 10 Doune gardens, Kelvinside. 1887  
 455 \*Muirhead, Robert F., M.A., B.Sc., Lochwinnoch. 1879  
 Munro, Daniel, 10 Doune terrace, Kelvinside. 1867  
 Munsie, George, 1 St. John's ter., Hillhead. 1871  
 Munsie, Robert George, 10 Berkeley terrace, West. 1883  
 Murdoch, Robert, 19 Commerce st. 1880  
 460 Murdoch, William, 79 Robertson street. 1879  
 \*Murray, David, 169 West George street. 1876  
 Murray, A. Erskine, Sheriff-Substitute of Lanarkshire, Sundown, Montgomerie drive. 1881  
 Napier, Alex., M.D., F.F.P.S.G., Rose Bank, Queen Mary avenue, Crosshill. 1886  
 Napier, James, jun., 15 Prince's square, Strathbungo. 1870  
 465 \*Napier, John, 23 Portman square, London. 1846  
 Nelson, Alex., 80 Gordon street. 1880  
 Nelson, D. M., 164 St. Vincent street. 1875  
 \*Newlands, Joseph F., 28 Renfield street. 1883  
 Newman, David, M.D., C.M., F.F.P.S.G., 18 Woodside place, W. 1877  
 470 Newbery, Francis H., Government School of Art, 3 Rose street. 1890  
 Ogilvie, William, 1 Doune terrace. 1881  
 Orr, Robert, 79 West Nile street. 1890  
 Osborne, Alex., 5 Oakley terrace, Dennistoun. 1870  
 Osborne, Robert, 3 Montgomerie crescent. 1890  
 475 Outram, D. E., 16 Grosvenor ter., Hillhead. 1878  
 Park, James, Millburn Chemical Works. 1877  
 \*Parker, John Dunlop, C.E., 146 West Regent street. 1889  
 \*Parnie, James, 32 Lynedoch street. 1874  
 Paterson, John, 522 Pollokshaws road. 1888  
 480 \*Paterson, Robert, C.A., 28 Renfield street. 1881  
 Paton, Jas., F.L.S., Corporation Galleries, and Kelvingrove Museum. 1876  
 Patterson, T. L., F.C.S., at John Walker & Co.'s, Greenock. 1873  
 Petrie, Alexander, I.A., 111 Bath street. 1885  
 Pirie, John, M.D., 26 Elmbank crescent. 1877  
 485 \*Pirrie, Robert, 9 Buckingham ter. 1875  
 \*Pollock, R., M.B., C.M., F.F.P. & S.G., Laurieston house, Pollokshields. 1883  
 Price, Rees, L.D.S., Eng., 163 Bath street. 1883  
 Pride, David, M.D., Townhead House, Neilston. 1887  
 \*Provan, James, 40 West Nile st. 1868  
 490 Provand, A. D., M.P., 8 Bridge street, London, S.W. 1888  
 Raalte, Jacques Van, 136 West Regent street. 1884  
 Ramsay, John, of Kildalton, 5 Dixon street. 1856  
 Ramsay, Robert, M.D., L.R.C.S.E., Lochwinnoch. 1881  
 Ramsay, Robert, 14 Park terrace. 1889  
 495 Rankine, David, C.E., 75 West Nile street. 1875  
 Rankine, Captain John, 137 St. Andrew's road, Pollokshields. 1869  
 Rattray, Rev. Alex., M.A., Parkhead parish, 4 Westercraigs, Dennistoun. 1879  
 Reid, Andrew, 20 North Albion st. 1875  
 Reid, David, 209 Sauchiehall street, 1887  
 500 \*Reid, Hugh, 10 Woodside terrace. 1880

- Reid, James, 10 Woodside terrace. 1870  
 Reid, James, 15 Montgomerie cres. 1889  
 Reid, J. G., 9 St. Vincent place. 1874  
 Reid, Thos., M.D., 11 Elmbank st. 1869  
 505 Reid, William, M.A., High School. 1881  
 \*Reid, William L., M.D., 7 Royal crescent, West. 1882  
 Reith, Rev. George, M.A., Free College Church, 37 Lynedoch st. 1876  
 Rennie, John, Sandbank, Clyde street, Partick. 1886  
 Renton, James Crawford, M.D., L.R.C.P.&S.Ed., 2 Buckingham terrace. 1875  
 510 Rey, Hector, B.L., B.Sc., 4 St. James' place, Hillhead 1889  
 Richmond, Thos., L.R.C.P.E., 26 Burnbank terrace. 1887  
 Ritchie, R. Brown, 79 West Regent street. 1883  
 Robertson, Archibald, 25 Queen st. 1863  
 Robertson, Archibald, Ballancleroch, Campsie Glen. 1884  
 515 Robertson, Rev. James, D.D., Professor of Oriental Languages in the University of Glasgow. 1884  
 Robertson, John, 10 Valeview ter., Langside, *Librarian*. 1860  
 Robertson, J. M'Gregor, M.A., M.B., 400 Great Western road. 1881  
 Robertson, Robert, Coplawhill, Pollokshaws road. 1877  
 Robertson, Robert A., 8 Park street, East. 1877  
 520 Robertson, Robert H., Clyde Bank, Rutherglen. 1888  
 Robertson, William, C.E., 123 St. Vincent street. 1869  
 Robson, Hazelton R., 14 Royal crescent, West. 1876  
 \*Rogers, John C., 163 W. George st. 1888  
 Rose, Alexander, Richmond House, Dowanhill. 1879  
 525 \*Rose, Charles A., 1 Belhaven cres. 1889  
 Ross, David, M.A., B.Sc., LL.D., E.C. Training College. 1888  
 Ross, Henry, 7 Park quadrant. 1876  
 \*Ross, John, 9 Westbourne gardens. 1885  
 Rottenburg, Paul, 21 St. Vincent place. 1872  
 530 Rowan, David, 22 Woodside place. 1863  
 Rowan, W. G., 234 West George street. 1881  
 Rundell, R. Cooper, Underwriters' Room, Royal Exchange. 1877  
 Russell, James B., B.A., M.D., LL.D., 3 Foremount terrace, Partick, *Hon. Vice-President*. 1862  
 Salmon, W. Forrest, F.R.I.B.A., 197 St. Vincent street. 1870  
 535 Schmidt, Alfred, 492 New City road. 1881  
 Scott, Alex., 2 Lawrence place, Dowanhill. 1871  
 \*Scott, D. M'Laren, 2 Park quadrant. 1881  
 Scott, Robt., I.M., 115 Wellington street. 1884  
 Simons, Michael, 206 Bath street. 1880  
 540 Simpson, P. A., M.A. Cantab., M.D., Regius Professor of Forensic Medicine, University, 1 Blythwood square. 1881  
 Sinclair, Alexander, Ajmere lodge, Langside. 1883  
 Sinclair, D., London. 1890  
 Smart, William, M.A., Nunholm, Dowanhill. 1886  
 Smellie, George, I.M., 167 St. Vincent street. 1880  
 545 \*Smellie, Thos. D., 209 St. Vincent street. 1871  
 Smith, D. Johnstone, C.A., 149 W. George street. 1888  
 Smith, Francis, 45 Gordon street. 1875  
 Smith, Harry J., Ph.D.; Coltness Iron-works, Newmains. 1877  
 Smith, Hugh C., 55 Bath street. 1861  
 550 \*Smith, J. Guthrie, 54 West Nile street. 1875  
 \*Smith, Robert B., Bonnybridge, Stirlingshire. 1884  
 Smith, W. R. W., Rosmor, Sandbank. 1868  
 Smith, William, jun., 1 University Gardens terrace, Hillhead. 1889  
 \*Somerville, Alexander, B.Sc., F.L.S., 4 Bute Mansions, Hillhead street, Hillhead. 1888  
 555 Somerville, David, 35 King street, S.S. 1885  
 Sorley, Robert, 3 Buchanan st. 1878  
 Spens, John A., 169 W. George st. 1879  
 \*Spiers, John, 43 Great Western road, Hillhead. 1885  
 Stanford, Edward C. C., F.C.S., Glenwood, Dalmuir, Dumbartonshire. 1864  
 560 \*Steel, William Strang, Braco Castle, Braco, Perthshire. 1889  
 \*Stephen, John, Domira, Partick. 1880  
 Stephen, Robt. R., Adelphi Biscuit Factory. 1867  
 \*Steven, Hugh, Westmount, Montgomerie drive. 1869  
 Steven, John, 32 Elliot street. 1875  
 565 \*Stevenson, D. M., 12 Waterloo st. 1889  
 \*Stevenson, Jas., F.R.G.S., 23 West Nile street. 1870  
 Stevenson, John, C.E., 208 St. Vincent street. 1885  
 Stevenson, William, Tower Bank, Lenzie. 1870

- Stevenson, Wm., 21 Clyde place. 1888  
 570 Stewart, Andrew, Jordanhill house. 1887  
 Stewart, David, 3 Clifton place. 1856  
 Stewart, James Reid, 30 Oswald street. 1845  
 Stewart, John, Western Saw Mills. 1877  
 Stobo, Thomas, Somerset House, Garelochhead. 1884  
 575 Stoddart, James Edward, 30 Renfield street. 1872  
 \*Strain, John, C.E., 154 West George street. 1876  
 \*Sutherland, David, Great Western Hotel, Oban. 1880  
 \*Sutherland, John, Great Western Hotel, Oban. 1880  
 Sutherland, J. R., Clifton place. 1884  
 580 Sutherland, Thos., 198 Parliamentary road. 1886
- Tatlock, John, F.I.C., 34 Gray street, Sandyford. 1875  
 Tatlock, Robt. R., F.R.S.E., F.I.C., F.C.S., 156 Bath street. 1868  
 Taylor, Benjamin, F.R.G.S., 10 Derby crescent, Kelvinside. 1872  
 Taylor, Thomas, 60 Montrose street. 1889  
 585 Teacher, Adam, 14 St. Enoch square. 1868  
 Tennant, Sir Charles, Bart., 195 West George street. 1868  
 Tennant, Gavin P., M.D., 159 Bath street. 1875  
 Terrace, David, Dawsholm Gasworks, Maryhill. 1883  
 Thomson, David, I.A., F.R.I.B.A., 2 West Regent street. 1869  
 590 Thomson, George C., F.C.S., 86 St. Vincent street. 1883  
 Thomson, Gilbert, M.A., C.E., 75 Bath street. 1885  
 Thomson, Graham Hardie, 2 Marlborough terrace, Kelvinside. 1869  
 \*Thomson, James, F.R.I.B.A., 88 Bath street. 1886  
 Thomson, James, F.G.S., 26 Leven street, Pollokshields. 1863  
 595 Thomson, Jas., LL.D., F.R.S., C.E., 2 Florentine Gardens, Hillhead. 1874  
 Thomson, Jonathan, 3 St. John's terrace, Hillhead. 1869  
 Thomson, Sir William, LL.D., D.C.L., F.R.S.S., L. & E., Professor of Natural Philosophy, University of Glasgow, *Hon. Vice-President*. 1846  
 Thomson, William, B.A., Linden, Bearsden. 1888  
 Townsend, C. W., Crawford street, Port-Dundas. 1890  
 600 \*Tullis, James Thomson, Anchorage, Burnside, Rutherglen. 1883
- Turnbull, John, 37 West George st. 1843  
 \*Turnbull, John, jun., M.I.M.E., 255 Bath street. 1883  
 Turner, George A., M.D., 1 Clifton place, Sauchiehall street. 1883  
 Turner, William, 33 Renfield st. 1875
- 605 Urie, John, 38 St. James' street, Kingston. 1876
- Verel, Wm. A., The Linn, Cathcart. 1883
- Walker, Adam, 35 Elmbank cres. 1880  
 \*Walker, Archibald, B.A. (Oxon.), F.C.S., 8 Crown ter., Dowanhill. 1885  
 Walker, James A., 112 St. Vincent street. 1884  
 610 Walker, Malcolm M'N., F.R.A.S., 45 Clyde place. 1853  
 Walker, William, 14 Victoria crescent, Dowanhill. 1890  
 \*Wallace, Hugh, 30 Havelock street. 1879  
 \*Wallace, Wm., M.A., M.B., C.M., Westfield House, Shawlands. 1888  
 Wardlaw, Johnston, 83 Taylor street. 1884  
 615 Warren, John A., C.E., 115 Wellington street. 1887  
 Watson, Archibald, 5 Westbourne terrace. 1881  
 Watson, James, Cluniter, Innellan. 1873  
 Watson, John, 205 West George street. 1886  
 Watson, Joseph, 225 West George street. 1882  
 620 \*Watson, Thomas Lennox, I.A., F.R.I.B.A., 108 W. Regent st. 1876  
 \*Watson, William Renny, 16 Woodlands terrace. 1870  
 Weir, Walter, C.A., Barskiven, Paisley. 1888  
 Welsh, Thos. M., 51 St. Vincent crescent. 1883  
 Wenley, James A., Bank of Scotland, Edinburgh. 1870  
 625 Westlands, Robert, 99 Mitchell st. 1869  
 White, John, Scotstoun mills, Partick. 1875  
 Whitelaw, Alexander, 87 Sydney street. 1855  
 \*Whitson, Jas., M.D., F.F.P. & S.G., 13 Somerset place. 1882  
 Whytlaw, R. A., 1 Windsor quadrant, Kelvinside. 1885  
 630 Widmer, Justus, 21 Athole gardens. 1887  
 Williamson, John, 65 West Regent street. 1881  
 Wilson, Alex., HydePark Foundry, 54 Finnieston street. 1874  
 Wilson, Charles, 76 Market street, East. 1875

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|------|--|--|
|      | Wilson, David, Carbeth, by Killearn. 1850                    | Wyper, James, 6 Burnbank gardens. 1878                           |
| 635  | Wilson, Richard J., St. George's<br>Road Public School. 1887 | Yellowlees, D., M.D., Medical<br>Superintendent, Gartnavel. 1881 |
|      | Wilson, William, Virginia buildings. 1881                    | Young, George Christie, City Saw<br>Mills, Port-Dundas. 1884     |
|      | Wilson, William, 290 Renfrew st. 1889                        |  |
|      | Wilson, W. H., 45 Hope street. 1881                          | 650 Young, John, 22 Belhaven terrace,<br>Kelvinside. 1885        |
|      | Wingate, Arthur, 6 Kelvin drive. 1882                        | Young, John, 64 Cochrane street. 1881                            |
| 640* | Wingate, John B., 7 Crown terrace,<br>Dowanhill. 1881        | *Young, John, jun., M.A., B.Sc.,<br>Dunard, Busby. 1887          |
|      | Wingate, P., 14 Westbourne ter. 1872                         | Young, R. Bruce, M.A., M.B.,<br>C.M., University. 1885           |
|      | Wingate, Walter E., 4 Bowmont<br>terrace. 1880               | *Young, Thos. Graham, Westfield,<br>West Calder. 1880            |
|      | Wood, James, M.A., Glasgow<br>Academy. 1885                  | 655 Younger, George, 166 Ingram<br>street. 1847                  |
|      | Wood, James, 40 St. Enoch square. 1886                       |  |
| 645  | Wood, Wm. Copland, Turkey-red<br>Works, Alexandria. 1883     | Zinkeisen, Victor, 225 George st. 1881                           |
|      | Woodburn, J. Cowan, M.D., 197<br>Bath street. 1869           |  |

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1. The first part of the document is a list of names and addresses of the members of the committee.

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